CARI
at a glance

भाकृअनुप
ICAR

ICAR-Central Avian Research Institute
(ISO 9001:2008 Certified)
Izatnagar-243 122 (UP) INDIA

ISO 9001:2008 Certified

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Foreword

Poultry industry in India has appeared as the most dynamic and fastest growing segments amongst agricultural sector today with an annual growth rate of 8.51% in egg and 7.52% in broiler production. This resulted India as world's third largest egg producer and fifth largest chicken meat producer country. This transformation had taken place in all the areas of farming such as breeding, nutrition, hatching, management as well as feed and product processing technologies, etc. The poultry sector is posting an annual turnover of 10,000 million dollars and satisfying the hungers of 20 million people through employment. Around 4 lakh farmers are engaged in poultry farming activities with 85% of them having less than 2 Hectare of land. Urban demand still accounts for 80% of domestic consumption. South India accounts for majority of the total poultry production and consumption in the country. Andhra Pradesh, Karnataka, Kerala, Tamil Nadu in south and Maharashtra in the west and Haryana, Punjab in the north are key regions in this aspect. In the recent past, poultry industry in North India specially Uttar Pradesh, the largest state is taking a big boom with a contribution of 47.32% and 2.6% meat and egg production in the country. U.P. Poultry Development Policy-2013 is a welcome development that has enhanced the lives of several farmers in this state. Technological support is therefore cruial for the sustained growth of poultry sector. Being, a premier poultry institute in U.P, this institute has shared a much of burden to bridge the gap for reaching the needy farmers with technological advancements. Despite the potential developments in Poultry industry, village or rural poultry production is still being untapped in terms of witnessing the ongoing progressive low cost technologies for sustainable poultry production. Technological support is therefore, crucial for the sustained growth of the poultry sector.

ICAR-Central Avian Research Institute (CARI) was established on the 2nd November, 1979 at Izatnagar, Bareilly, Uttar Pradesh under the aegis of the Indian Council of Agricultural Research (ICAR) to provide all-round support to the growth of poultry sector. Since its inception, this Institute has been playing an important role by providing need based R&D support for diversified poultry production, processing and marketing, apart from Post-graduate education, training and technology transfer activities for augmenting productivity, production and profitability of the Indian poultry sector. Moreover, the Institute has been continuously updating and reorienting its R&D focus abreast with the latest developments taking place globally and in accordance with the changing needs of the domestic poultry sector. This institute has been the major driving force steering the Indian poultry sector through various phases of development during the past four decades providing much needed technological support to the poultry industry especially the rural poor.

The institute has also made significant contributions towards evaluation and standardization of alternate and newer feed resources to help in lowering down the feed cost besides developing feed formulae for computing low cost ration under different climate and regions of the country. The improvement in feed efficiency has also been brought through increasing the nutrient availability. Institute has developed the protocols for about two dozen value added processed products utilizing poultry egg, meat and byproducts and development of methods for their shelf-life extension. The universal semen extender for different poultry species was developed which can maintain the fertility till 24 h. Besides, the institute has also contributed significantly in frontier research like molecular genetics and biotechnology, nutrigenomics, metagenomics. Institute's HRD program has been providing trained manpower for manning large commercial poultry houses in the country. This institute is only one of its kinds wholly dedicated to Poultry Science research, education and extension in the country with the following vision, mission and the mandate.

(Ashok Kumar Tiwari)
Director

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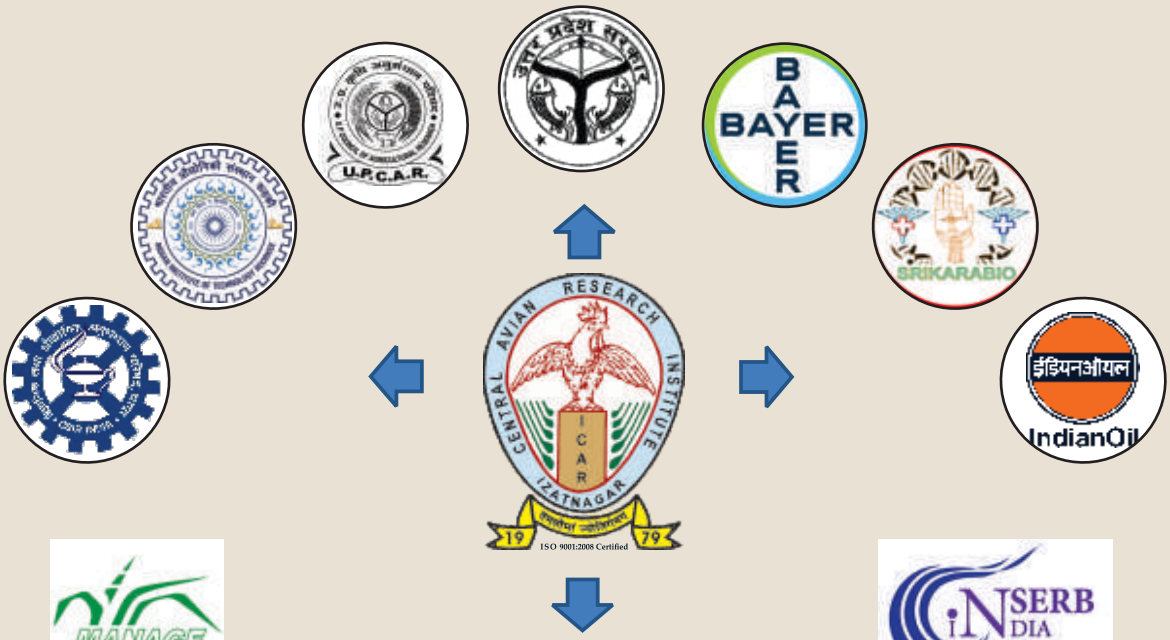
Linkages



GOVERNMENT OF INDIA | MINISTRY OF SCIENCE AND TECHNOLOGY
जैवप्रौद्योगिकी विभाग
DEPARTMENT OF BIOTECHNOLOGY

फार्मर फर्स्ट

ICAR-National Agricultural Science Fund (NASF)
भा.कृ.अनु.प.-राष्ट्रीय कृषि विज्ञान कोष

भारत की आज़ादी का अमृत महोत्सव

Introduction

Central Avian Research Institute (CARI) was established on the 2nd November, 1979 at Izatnagar, Bareilly, Uttar Pradesh under the aegis of the Indian Council of Agricultural Research (ICAR) to provide all-round support to the growth of poultry sector. Since its inception, this Institute has been playing an important role by providing need based R&D support for diversified poultry production, processing and marketing, apart from Post-graduate education, training and technology transfer activities for augmenting productivity, production and profitability of the Indian poultry sector. The Institute remains responsive and vigilant to the ever evolving needs of the poultry sector through development of cutting edge technologies targeting specific problems faced by the industry. The R&D accomplishments of the Institute have been widely acclaimed as evident from a long list of prestigious national and international awards and laurels the Institute has been adorned with.

Mandate

- Basic and applied research on productivity enhancement for sustainable production in diversified avian species.
- Human resource development and capacity

Vision

Revolutionizing the diversified poultry production for household nutritional security, income and employment generation as a viable alternative to chicken.

Mission

Developing and popularizing appropriate poultry production and processing technologies in respect of diversified avian species for enhanced profitability.

Landmark contribution of the institute in poultry research

Way back in 1930's the role of poultry in fighting poverty and malnutrition was recognized. Accordingly, on the recommendations of the Royal commission on Agriculture (1927)/ a separate poultry Research Section was established in erstwhile Imperial Veterinary Research Institute, Izatnagar, Bareilly (UP) on March 11, 1939. Later, the Section became a full-fledged Poultry Research Division (PRD) and continued to play a significant role in development of Indian poultry industry. Mr. Macdonald (1939-1947) was the first Head of the PRD. The significant achievements of the PRD and its all-round support to the progress of poultry sector in the country contributed to upgrading of the erstwhile PRD to the status of the Institute during the V Plan and thus, the Central Avian Research Institute (CARI) – combining the PRD and the Coordination Union of AICRP on Poultry Breeding, came into existence on November 2, 1979.

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The technological breakthroughs led by ICAR-CARI, the oldest and only research institute of its kind under the aegis of the ICAR wholly dedicated to poultry science research have contributed significantly towards the evolution and transformation of backyard/free range small scale subsistence poultry into fully developed intensive commercial farming in the country. As a result, the Indian poultry sector has been growing @ 8% per annum, with 1.1% share in GDP and 11.2% of the livestock GDP.

1. Germplasm development

- Minimizing the dependence of Indian poultry sector on imported poultry stock, the institute has made significant strides in developing and propagating improved germplasm chicken broilers and layers and those of diversified poultry such as Japanese quails, turkey, Guinea fowl, ducks and desi fowls throughout the country. Their production technologies have been disseminated not only to the poultry corporates in private sector but also to CPDOs, SAUs/SVUs, KVKs, State AH departments and NGOs etc. which in turn have been providing the germplasm to the poultry farming community in their respective command areas. During past four decades, the marketable age of the broiler chickens has been reduced approximately by one day each year and FCR has been decreased by 0.04 each year, and this trend is continuing.

The following landmarks in the field of Avian Genetics and Breeding including Biotechnological advancements in the country have been responsible for the spiraling growth of the poultry sector.

- The indigenous poultry breeds of different regions of the country were catalogued and characterized based on phenotype and utility (viz. egg, meat, dual purpose).
- Introduction of quail (1974) in the country as an alternate species for egg and meat production. Similarly, turkey germplasm was also introduced for diversification of poultry production systems.
- Specialized selection and breeding program for layer and broiler were developed in the country for development of great grand-parents, grand-parents and parents for developing commercial crosses for desired goals.
- Introduction of imported improved layer (1965) and broiler (1974) hybrids.
- Inception of All India Co-ordinated Research Projects for Egg and Meat (1971) for developing location specific superior germplasm at different centres and their dissemination throughout the country.
- The intensive selection in layers and broilers were initiated in 1970's. The selection program involved index and mass selection for bringing desired improvement.
- Global advancement in statistical analytical tools (1975) and their utilization in data analysis in India resulted in more precise evaluation of variance components using advance statistical procedures like ML, REML, MINQUE and MIVQUE, BLUP.
- New improved varieties involving desi, CARI Red and broiler germplasm were developed viz. CARI GRACY, CARI SALONI, GK75 and CSML× Desi. Similarly, Chitkovery and black varieties of turkey have been developed. The Institute has been serving as the nerve centre for popularizing and propagating quails, Guinea fowls and turkey and for spread of their germplasm throughout the country.
- R & D on Host × Pathogen interaction was focused (1985 onwards) and augmenting disease resistance in high yielding poultry strains (2000 onwards).
- Various poultry germplasm were analysed through molecular and immunological techniques under induced challenge with various bacterial (E. coli and S. Typhimurium) and viral (IBD, NDV, H5N1 and RSV-A) pathogens.
- Initiation of R&D on development of molecular tools (RAPD, microsatellite and AFLP) for poultry breed/line/strain/characterization during led 80s to frontier research in poultry. Functional genomics using candidate genes for production, reproduction was started in 2000s at CARI. Subsequently use of transcriptomics was started for pathways analysis and identification of important/major genes.
- Use of Biotechnological tools like transgenesis (1998 onwards) and RNAi (2000 onwards) to break the yield barriers as well as using poultry for different specified goals was initiated. Transgenic sperm production was the first step in this direction. Under RNA application in vitro, in vivo and silencing of myostatin, TGF-4 ACC-1 and PPAR genes in chicken were achieved.
- Metagenomic analysis (2010 onwards) of poultry gut (Indigenous chicken and Guinea fowl) microbiome for identification of new pro-biotic strains was initiated. Host specific lactobacillus was isolated and identified from the gut of diversified poultry species as a probiotic candidate for broiler chickens.
- Molecular markers to differentiate domesticated and wild quails was developed to provide molecular differentiation and identification of domesticated Japanese quail

from wild quail where species differentiation between Japanese and wild quail based on morphological trait is not unequivocal.

- Bringing poultry of OGL (now on unrestricted import list) for duty free import of improved germplasm of poultry species for bringing faster genetic improvement an enhancement of productivity.

2. Nutritional intervention to reduce cost of production:

The institute has devised ways and means to ensure precise nutrient supply through development of feeding standards for different classes and age groups of diversified poultry under different rearing conditions being followed by commercial private sector and farmers. The feeding value of more than a dozen of alternate agro-industrial fed resources (energy and protein) has been established for cost-efficient feed formulation. The bio-availability of nutrients has been augmented from conventional and non –conventional feed resources through cost-effective and efficient processing techniques and feed additives for increasing poultry production within the available feed resources. The institute has identified a number of non-conventional feed stuffs such as de-oiled cakes of sunflower/ safflower/mustard/ cotton seed/ cassava/guar/DDGS and brans etc. which have changed the whole gamut of their economic trade owing to their importance the poultry feed. The anti-nutritional factors, mycotoxins and resides in feed have also been effectively ameliorated. Specifically, the following achievements have significantly contributed to the growth of poultry sector in India.

- The feeding standard for different categories of poultry has been developed in India (published by ICAR and BIS) for precise nutrient supply.
- Feed processing technology for production of balanced compound feed has been improved for augmenting nutrients bio--availability, production performance and gut health.
- Various feed additives, feed supplements and biotechnological innovations (feed enzymes including cocktail enzymes, protease, synthetic, amino acids and vitamins, inorganic and organic mineral premixes, toxin binders, liver tonic, immune--stimulants, herbal antimicrobials, pre and prebiotics, anti-oxidants. etc.) have been developed and evaluated for improving feed utilization, survivability, carcass traits (microbial and nutritional), and reduction of pre-harvest losses leading to improved welfare of birds and profitable clean and green poultry production.
- Production of designer egg and meat through genetic and dietary manipulations such as, low cholesterol eggs enriched with omega-3 fatty acids and vitamin E have been developed through dietary manipulations.

- Innovative feed additives viz. probiotic, prebiotics, synbiotics, betaine, spirulina, postbiotics, sea weeds, phytobiotics, nucleotides etc. have been standardized for maximizing efficiency in poultry.
- Methods to mitigate heat stress in poultry through dietary manipulations were standardized.
- Formulating the least-cost balanced diets using locally available ingredients also contributed significantly towards cost-cutting in poultry farming.

3. Improvement of reproductive efficiency and health in poultry

The institute has played a significant role by way of developing and disseminating the improved semen diluent, fertility prediction test, control of reproductive disorders like atresia, internal laying in broiler breeders optimizing the artificial insemination techniques in different poultry species and management of summer stress including improved moulting techniques for layers, economic poultry production and addressing welfare issues. The technologies developed the institute have been adopted by the private sector leading to substantial reproduction in mortality and morbidity in poultry. The technological breakthroughs in the last four decades have contributed significantly to the development of poultry in the country.

- Developing baseline at for various haemato-biochemical parameters and structure and functioning of various systems.
- The techniques of artificial insemination for various poultry species were developed with the advent of commercial intensive poultry farming.
- Fertility prediction test for male Japanese quails was developed (2002).
- Developed the method for nitrate and nitrite estimation in biological fluids (2002).
- Established the role of anti-oxidants and micronutrients in avian reproduction (2005 onwards).
- Welfare friendly technique of moulting in poultry as an alternative to the traditional method of feed withdrawal was standardized (2008).
- Established the base line values for semen characteristics in Japanese quails and Guinea fowl (2010 onwards).
- New semen diluent for Japanese quail was developed (2010).
- Developed a technique of RNA isolation from chicken spermatozoa (2014).
- The problem of internal ovulation of eggs in broiler breeders was addressed using phytohormones (2014).

- Developed a technique for measuring blood pressure and heart rate invasively using blood pressure recording system; for which anaesthetic combinations of Ketamine and Diazepam were standardized (based on least cardio-depression attained) accordingly for broilers (2016).
- Scoring coefficients for assessing the extent of heat stress impact on fast growing broilers were developed by considering the data generated for various stress responses (2016).
- Concept of addressing reproductive dysfunctions in coloured broiler breeders was developed using GnRH analogues (2018).
- Dietary and photoperiod strategies were standardized to break the seasonality of reproduction in guinea fowls during winter (December-March) (2018).
- A new and simple diluent for storage of chicken semen has been developed along with standardization of storage temperature, duration, air volume ratio of collection tubes (2018).
- The important interventions in the field of avail health and bio security have been followed leading to significant reduction in the mortality and morbidity rates in poultry.

4. Housing Systems and Package of Practices

The Institute has pioneered the rearing and management practices of different poultry species under diversified rearing systems. Entire range of rearing appliances such as battery brooders, feeders, incubation trays, laying and fearing cages, waterers, etc. for different avian species have been designed and fabricated. The Institute has also designed low cost poultry houses utilizing locally available materials for semi-intensive or small scale poultry farming. Following advances in poultry housing and management have fuelled the growth of poultry sector in India.

- Designing and development of cages (1975) for high intensity poultry production.
- Advancements in building design including rodent and reptile proofing, proper ventilation and cooling systems, building materials and devices controlling temperature. Moisture and gaseous pollutants in poultry houses leading to minimization of environmental stress and consequent improvements in productivity.
- Cage space requirement for commercial layers has been redefined.
- Technique of delivering nutrients directly to embryo (in-ovo) has been optimized for chicken.

- Optimized transportation conditions for enhancing welfare of broilers under Indian scenario.
- A low cost all weather rural poultry incubator was developed from the discarded refrigerator.
- A Girigram integration model for 1 acre land has been developed with an aim of doubling farmer's income.

5. Processing, value Addition and product quality including waste management

The Institute has developed a number of value added products utilizing poultry eggs, meat, culled birds and slaughter waste including leaking eggs and hatchery waste etc. The effective and economical techniques of preservation/ shelf of extension including suitable packaging of poultry products have also been standardized. The technique of meat tenderization has been standardized to pave the way for effectively utilizing tough meat of culled birds. The institute has also generated information base on bio and phyto-

contaminants to address food safety concerns. Half a dozen value addition processes have been commercialized. Specific landmarks developments in the processing sector have been as follows.

- Development of thermal death protocols for inactivation of pathogens during processing and prediction models for control.
- Standardization of protocols for preparation of poultry products, RTE and RTC products.
- Development of functional foods.
- Production of biogas with DAC technology exclusively from poultry droppings has been standardized.
- More than 20 meat and egg products have been developed with the standardization of their preparation.
- Incorporation of Lactobacillus plantarum NKN51@ 107cfu/g along with lead combination of antimicrobials (Thymol, Carvacrol, Linalool, vitamin C and CuSo4 with 1.5× concentration) and addition of MOS @0.3% as prebiotic and sodium butyrate @ 0.03 % as a feed acidifier.

6. Institutional and Policy Support

With the growth of poultry sector in India, several institutional support systems were also developed. Several schemes to support poultry sector have been instituted by stage and central governments as well as by public sector banks. The institute provides much needed support of formers in form of training in poultry farming and also through preparation of over 40 bankable projects for loan purposes. An agribusiness incubator center was established for Building eco system for steering poultry entrepreneurship.

7. HRD and Capacity Building

The human resource development and capacity building is one of the major activities of the institute. The institute has already produced over 400 past graduates in Poultry Science discipline, who are manning various poultry corporate, Govt. departments and R&D Institutions engaged in poultry research etc. The capacity building exercise is taken up by this institute in the form of short term and specialized trainings on various aspects of diversified poultry production, management, processing and entrepreneurship. A total of over 500 trainers have been trained in designated specialized fields of poultry science. Besides, a total of over 5000 persons have been imparted training on Poultry Production and Management. Other modes of capacity building such as summer/winter schools, farmers fair, conferences, seminars and symposia are also organized by the Institute from time to time.

8. Software packages developed

The nutritional package of practices have been made available to the target beneficiaries (poultry feed manufacturers, poultry farmers and R&D institutions through MakeFeed Poultry, the Window raised software developed to design cost effective feed-formulae for different classes and age groups of various poultry species, which has been immensely popular and over 450 copies have already been sold. Android based mobile applications have been developed for CARI institute and Desi chicken farming.

ORGANOGRAM

DIRECTOR

- **INSTITUTE MANAGEMENT COMMITTEE**
- **RESEARCH ADVISORY COMMITTEE (RAC)**
- **INSTITUTE RESEARCH COUNCIL (IRC)**

ADMINISTRATION

- Bill and Cash
- Establishment
- General and Contract
- Audit and Accounts
- Central Store
- Telecommunication
- Transport
- Record
- Hindi Cell

SCIENTIFIC

DIVISIONS

- Avian Genetics & Breeding
- Avian Nutrition & Feed Technology
- Avian Physiology & Reproduction
- Post-Harvest Technology

SECTIONS

- Post-Graduate Education & Training
- Avian Medicine
- Poultry Housing & Management
- Poultry Economics & Agribusiness Research
- Prioritization, Monitoring & Evaluation
- Technology Transfer

EXPERIMENTAL FARMS

- Quail
- Turkey
- Guinea Fowl
- Desi Fowl
- Layer
- Broiler
- Emu

SERVICE UNITS

- Hatchery
- Feed Storage & Processing Unit
- Agriculture Knowledge Management Unit
- Institute Technology Management Unit
- Agribusiness Incubation Center
- Library
- Poultry Processing Unit

AUXILIARY

- Vigilance Cell
- Publication Cell
- Engineering and Maintenance Unit
- Security Section
- Estate Section
- Games and Sports Unit
- Staff Welfare Club
- Medical Unit
- Marketing Centre

CARI MILESTONES.....

1980-81
- ILI-80 (Layer chicken)
- CARI Pearl (Layer quail)

1982-83
- Adoption of nutrient requirements by ISI
  Pickled quail eggs
- Chicken patties
- Introduction of Guinea fowl

1985-86
- Non-conventional feedstuff
- Chemical dip for meat preservation
- Role of Ca in glucose absorption

1988-89
- Poultry manure as alternate feed
- Polyphosphate chilling of dressed quail/ chicken
- Chicken gizzard pickle (Patented)

1990-91
- Unique factor in quail foam - Effects on motility and fertilizing ability
- Preservation of hard cooked eggs
- Chicken nuggets

1991-92
- CARIBRO 91 broiler
- Oil coating preservation of quail eggs
- Chicken loaves (Patented)

1992-93
- CARI Golden (Brown egger)
- Revision of ISI requirements based on recommendations
- Adoption of safety levels of aflatoxin by BIS

1994-95
- Updating nutrient requirements
- Functions of stress hormones
- Modified atmosphere packaging of chicken patties
- Chicken steaks

1995-96
- Sperm motility inhibiting factor in chicken semen
- Cooked chicken stock (Patented)
- Egg patties

1997-98
- Introduction of turkey
- Marinated chicken fillets
- Cooked gizzard stock
- Cooked chicken rolls (Patented)
- Egg pancake

1998-99
- CARI Uttam (Broiler quail)
- Feeding standards for Japanese quails
- Egg crust pizza

1999-2000
- CARI Ujjawal (Dual purpose quail)
- CARI Virat (White turkey)
- Enhancement of phytate phosphorus bioavailability

2000-01
- CARIBRO Mrityunjay
- CARIBRO Dhanraja
- CARI Nirbheek
- CARI Shyama

  (Backyard boon)
- Upkari
- Hitkari
- Semen diluent at room temperature
- Fertility prediction test for male Japanese quail
- Dehydrated chicken meat stock
- Chicken gizzard snacks
- Pet food from poultry processing wastes

2001-02
- CARI Priya (White egger)
- CARI Sonali (Brown egger)
- CARI Debendra (Dual purpose chicken)
- CARI Sweta (Dual purpose quail)
- Chicken skin-meat cutlets
- Chicken soup premix

2002-03
- Low cost poultry houses
- Updating nutrient requirement of CARIPRIYA
- New nitrite and nitrate analysis method in quail semen
- Green berseem feeding for turkey
  Egg crepes

2003-04

- CARIBRO Tropicana
- CARI Brown (Broiler quail) to overcome the problem of Wild Life Preservation Act
- In ovo injection of amino acids and glucose

2004-05

- Feeding standards for backyard poultry
- Make-Feed poultry software
- Management of mycotoxicosis
- Molecular characterization of various
- poultry species using RAPD and
- microsatellite markers

2005-06

- Protein and coarse cereal mixtures
- Area-specific low cost nutritional package
- Stuffed egg
- Technology for low input backyard poultry production
- Specialized immunocompetent lines of broilers, layers and guinea fowl for disease resistance

2006-07

- Safety assessment of genetically modified crops in poultry feeding
- *In ovo* vaccination technique
- Molecular characterization of interleukin-2 gene in Red Jungle Fowl
- Egg strips (72.5% blended liquid whole egg and 5% soy flour, etc.)
- Processing of cereals for augmenting nutritive value
- Determining amino acids availability of Indian feedstuff

2007-08

- CARISONALI secured 2nd position in the 17th RSPPT at Gurgaon
- Dual purpose crosses of duck for free range farming
- Meat pellets with minced meat from spent hen and broiler (1:1)
- Augmenting gut health through biotechnological innovations
- Feed sanitizer for safe meat production

2008-09

- CARIBROVISHAL topped in 30th RSPPT

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- Semen diluents patent
- Poultry welfare during transportation
- Improved varieties of native chicken
- Agribusiness Incubation
- CARI rural poultry incubator from discarded refrigerator
- Launched societal developmental programmes for Scheduled caste and schedule tribes

Commercial White Egg Laying Chicken

CARIPRIYA™

Breeders of egg type chicken are primarily concerned with the development of quality layers in terms of feed efficiency, low chick cost and high egg production. CARl Priya, earlier known as ILI-80, is one such white egg layer. CARl Priya was developed by crossing superior male and female lines of White Leghorn.

Production Characteristics

Maturity	First egg	17 to 18 weeks
	50% production	150 days
	Peak production	26 to 28 weeks
Livability	Growing	96%
	Laying	94%
Egg production	Peak	92%
	Hen housed to 72 weeks	More than 298 eggs
	Hen day to 72 weeks	More than 301 eggs
Feed consumption	Per dozen of eggs	1.77 kg
	Per kg of egg mass	2.57 kg
Egg size	Average egg weight	57 g

Special Features

- Efficient feed conversion
- High positive return over feed cost

Commercial Brown Egg Laying Chicken

CARISONALI

To cater the need and high demand of the consumers, this golden brown egger was developed and released for its commercial exploitation in the year 1992 using White Leghorn as male line and Rhole Island Red as female line.

Production Characteristics

Maturity	First egg	18 to 19 weeks
	50% production	155 days
	Peak production	27 to 29 weeks
Livability	Growing	96%
	Laying	94%
Egg production	Peak	90%
	Hen housed to 72 weeks	More than 280 eggs
	Hen day to 72 weeks	More than 283 eggs
Feed consumption	Per dozen of eggs	2.3 kg
	Per kg of egg mass	3.8 kg
Egg size	Average egg weight	54 g

Special Features

- Lays brown eggs
- Efficient feed conversion
- High egg production

Dual Purpose Chicken

CARIDEBENDRA

CARl Debendra is a medium-sized dual-purpose bird, produced by crossing coloured synthetic broiler line as male line and Rhode Island Red as female line. It is the most suitable bird for the Indian consumers due to its attractive bright plumage colour. The meat has lower carcass and abdominal fat than broiler meat, which makes it a consumer's delight. CARl Debendra is also a suitable bird for rural poultry because of its better survivability and moderate egg production ability.

Production Characteristics

Body weight at 8 weeks	1100-1200 g
Body weight at 10 weeks	1400 to 1500 g
Body weight at 12 weeks	1700 to 1800 g
Feed conversion ratio (0-8 week)	2.5-2.6
Age at sexual maturity	155 - 160 days
Annual egg production	190-200
Livability (Growing)	97%
Livability (Laying)	94%

Special Features

- Efficient feed conversion
- Low laying house mortality

Commercial Broiler Chicken

CARIBROVISHAL (White Broiler)

It is high yielding broiler stocks, entirely different from imported commercial broiler stocks available in the market. It has been the endeavour of the Institute and it excels in the important areas of growth, feed efficiency, livability, meat quality and also the plumage colour with high performance features in tropical climate.

Production Characteristics

Body weight at day old	43 g
Body weight at 6 weeks	1650 to 1700 g
Body weight at 7 weeks	2000 to 2150 g
Dressing percentage	75-80
Livability percentage	97-98
Feed conversion ratio at 6 weeks	1.85

Special Features

- Superior growth rate
- High disease resistance
- Low production cost
- Suitable to Indian climatic and managemental conditions

CARIBRODHANRAJA™ (Coloured Broiler)

CARIBRO Dhanraja is a commercial cross produced by crossing coloured synthetic male and female lines. This stock is characterized by its bright plumage colour with single comb. It is also less susceptible to adverse environmental conditions. CARIBRO Dhanraja is the most preferred bird among farmers because of its multicoloured plumage and high economic returns.

Production Characteristics

Body weight at day old	46 g
Body weight at 6 weeks	1500 to 1700 g
Body weight at 7 weeks	2000 to 2125 g
Dressing percentage at 6 weeks	73-75
Livability percentage at 6 weeks	96-98
Feed conversion ratio at 6 weeks	1.85

Special Features

- Multicoloured and hardy
- Efficient feed conversion
- Optimum dressed carcass yield

Improved Indigenous Fowl

Different types of high yielding germ-plasm suitable for backyard poultry production have been developed with native fowl base especially suitable for different climatic regions of the country. These birds have combination of 50% native and 50% exotic blood and possess other characteristics essential for backyard/scavenging poultry production. Phenotypically these birds look like their original native breed with almost two times more egg production with bigger size and weight, better tropical adaptability and disease resistance along with capability of bearing the stress of sub-optimal feeding and management.

CARINIRBHEEK

It is a cross of Indian native breed Aseel with CARl Red. Birds are active, large in built, pugnacious in nature with high stamina and majestic gait. They are able to save themselves from their predators due to their fighting characters and activeness and are adapted to all climatic zones of the country.

Production Characteristics

Body weight at 20 weeks (Males)	1847 g
Body weight at 20 weeks (Females)	1350 g
Age at sexual maturity	176 days
Annual egg production	198
Egg weight at 40 weeks	54 g
Fertility	88%
Hatchability (FES)	81%

CARISHYAMA

It is a cross of Kadakanath breed of Indian native chicken with CARl Red. Birds have plumage of various colours dominated by black. The skin, beak, shank, toes and soles are dark gray colour. The peculiarity of this bird is that most of the internal organs show the characteristic black pigmentation. Varying degree of blackish colouration is also found in skeletal muscles, tendons, nerves, meninges, brain and bone marrow. The black colour of muscles and tissues is due to deposition of melanin pigment which causes increase in protein and decrease of fat thickness of muscle fiber, because of which meat from older birds are tender.

Production Characteristics

Body weight at 20 weeks (Males)	1460 g
Body weight at 20 weeks (Females)	1120 g
Age at sexual maturity	170 days
Annual egg production	210
Egg weight at 40 weeks	53 g
Fertility	85%
Hatchability (FES)	82%

UPCARI

Indian native chicken with Frizzle plumage has been crossed with CARI Red for development of UPCARI birds. These multicoloured birds have single comb and medium body size. Presence of Frizzle plumage helps in fast heat dissipation due to which birds are better adapted to tropical climate specially for arid zones.

Production Characteristics

Body weight at 20 weeks (Males)	1688 g
Body weight at 20 weeks (Females)	1285 g
Age at sexual maturity	165 days
Annual egg production	220
Egg weight at 40 weeks	60 g
Fertility	90%
Hatchability (FES)	84%

CARI
at a glance

HITCARI

HITCARI birds have been developed by crossing the Indian native Naked neck with exotic breed CARI Red. The neck region is devoid of feathers and there is reduction of 30 to 40% feathers on the body. The reduction in feathers help in internal heat dissipation which increases the tropical adaptability due to which there is no reduction in egg production and egg shell thickness during extreme summer. There is a decrease in heat stress mortality, increase in fertility and hatchability during summer and protein requirement for juvenile growth is reduced. These birds are very suitable for rearing in the hot humid coastal region.

Production Characteristics

Body weight at 20 weeks (Males)	1756 g
Body weight at 20 weeks (Females)	1320 g
Age at sexual maturity	178 days
Annual egg production	200
Egg weight at 40 weeks	61 g
Fertility	92%
Hatchability (FES)	81%

New Improved Varieties (under evaluation)

CARIDhawal

The dual type climate resilient white plumaged (frizzle) cross has developed for efficient egg production in intense summer/tropical conditions. Its laying capacity is about 250-260 eggs per annum.

CARINirasafed

The dual type climate resilient white plumaged (naked neck) cross has developed for efficient egg production in intense summer/tropical conditions. Its laying capacity is about 250-260 eggs per annum.

CARIPrabal

Birds are active, large in built, pugnacious in nature. They are able to save themselves from their predators due to their fighting characters and activeness and are adapted to all climatic zones of the country. Its laying capacity is around 160-170 eggs per annum.

CARISaloni

The skin, beak, shank, toes and soles are dark gray colour with muscle and most internal organs having black pigmentation due to deposition of melanin pigment. Its laying capacity is about 160-170 eggs per annum.

CARIGracy

It is a cross of Nicobari male and CARI-red female with plumage of various colours of black, brown and red. Its laying capacity is about 220-225 eggs per annum.

Improved Guinea Fowl Varieties

The Guinea Fowl birds were developed through selection and breeding programme from a wide base stock of indigenous. These birds are improved for high disease resistance and better growth rate. Three varieties of birds viz. Kadambari, Swetambari and Chitambari are available for commercial utilization. It is a hardy bird, suitable for any agro-climatic condition. There is no requirement of elaborate and expensive housing. It has excellent foraging capabilities and consumes all non-conventional feed not used in chicken feeding. It is more tolerant to mycotoxins. The hard egg shell provides minimum breakage and long keeping quality. Guinea fowl meat is rich in vitamins and low in cholesterol.

KADAMBARI

Production Characteristics

Body weight at 8 weeks	600-620 g
Body weight at 12 weeks	1000-1035 g
Age at first egg	230-250 day
Egg weight	40-43 g
Egg production (March to September)	100-120 eggs
Fertility	70-73%
Hatchability on fertile eggs set	70-78%
Livability	Excellent

Special Features

- Kadambari has black plumage with white and uniformly distributed spot.

CHITAMBARI

Production Characteristics

Body weight at 8 weeks	600-620 g
Body weight at 12 weeks	1000-1035 g
Age at first egg	230-250 day
Egg weight	40-43 g
Egg production (March to September)	100-120 eggs
Fertility	70-73%
Hatchability on fertile eggs set	70-78%
Livability	Excellent

Special Features

- Chitambari has white spot on gray plumage.

SWETAMBARI

Production Characteristics

Body weight at 8 weeks	525-560 g
Body weight at 12 weeks	920- 960 g
Age at first egg	230-250 day
Egg weight	38-40 g
Egg production (March to September)	100-115 eggs
Fertility	60-65%
Hatchability on fertile eggs set	70-80%
Livability	Excellent

Special Features

- Swetambari is pure white in colour.

Developed and Improved Varieties of Domesticated Japanese Quails

Japanese quail (*Coturnix coturnix japonica*) has created a huge impact in poultry sector and many quail farms have been established recently throughout the country, both for egg and meat production. CARl has been a nerve centre for introduction, genetic improvement and developing quail production technology in India since 1974. Through concerted efforts, a workable package of feeding, management and health care practices have been developed to support quail production in a scientific manner. This Institute has been maintaining six different plumage coloured pure lines of quail (broiler and layer types), and their consistent supply to both public and private sectors in the country for research and development as well as commercial exploitation.

CARIUTTAM (Broiler Quail)

Production Characteristics

Body weight (4th week)	150-155 g
Body weight (5th week)	250 g
Feed efficiency (4th week)	2.51
Feed efficiency (5th week)	2.60
Average egg weight	12-13 g
Colour of eggs	Tinted
Daily feed consumption	20-22 g
Hatchability on total egg set	70-75%

Better livability, body weight gain, feed conversion and profit

CARIPEARL (White Egger)

Production Characteristics

Body weight (5th week)	140 g
Daily feed consumption	18-20 g
Age at 50% egg production	8 weeks
Age at 80% egg production	10 weeks
Average egg weight	9 g
Colour of eggs	Tinted
Hen day production	285-300 eggs
Hatchability on total egg set	70-80%

High egg production and egg also ideal for biological research

CARIUJJAWAL (White Breasted Quail)

Production Characteristics

Body weight (4th week)	140 g
Body weight (5th week)	175 g
Feed efficiency (5th week)	2.70
Average egg weight	11 g
Colour of eggs	Tinted
Daily feed consumption	20-22 g
Hatchability on total egg set	70%

CARISWETA™ (White Feathered Quail)

Production Characteristics

Body weight (4th week)	150 g
Body weight (5th week)	160-170 g
Daily feed consumption	25 g
Feed efficiency (4th week)	2.60
Feed efficiency (5th week)	2.70
Average egg weight	10-11 g
Colour of eggs	Tinted
Hatchability on total egg set	60-65%
Plumage colour	Completely white feather

CARIBROWN (Brown Feathered Quail)

Production Characteristics

Age at sexual maturity	40 days
Body weight (4th week)	160 g
Body weight (5th week)	180-185 g
Average egg weight	11 g
Colour of eggs	White and tinted
Hatchability on total egg set	60-70%
Plumage colour	Completely brown

CARISUNEHERI (Brown Feather White Breasted)

Production Characteristics

Age at sexual maturity	42 days
5th Week body weight (straight-run)	180 g
Feed conversion ratio (5th week)	2.70
Average egg weight	11 g
Colour of eggs	White and Tinted
Age at 50% egg production	8 weeks
Age at peak egg production	12 weeks
Livability (0-5 weeks of age)	95%
Hatchability on total egg set	60-70%
Plumage colour	White breasted brown

Improved Turkey Varieties

CARl Virat (Turkey mixed) is mainly reared for meat. It is one of the famous white meat known for its leanness. It is a popular delicacy especially for festive occasions like Christmas and New Year. Turkey meat has tremendous commercial viability because of its low fat and cholesterol contents. It is quite suitable for upliftment of small and marginal farmers. Turkey can be easily reared in free range or semi-intensive system with minimal investment for housing, equipments and management

CARIVIRAT

Production Characteristics

Age (week)	Body weight (g)	Feed Conversion Ratio
6	1054	1.85
8	1748	2.05
10	2101	2.37
12	2778	2.80
24	5270	3.78
32	7100	4.15
Fertility	94%	
Hatchability	86%	

Special Features

- Low fat & cholesterol
- Suitable for backyard rearing

Value Added Poultry Products

I. Processed Value-Added Poultry Meat Products

1. Development of Poultry Meat Wafer

Meat products are highly perishable in nature and need refrigeration facilities for their preservation. The expenditure incurred to assure uninterrupted cold chains for handling them is usually high. So, a process formulation was standardized for development of shelf-stable poultry meat wafer. Formulation containing combination of turkey and spent hen meat (70:30) mince 70%, table salt 1.0%, sodium tri-polyphosphate 0.2%, skimmed milk powder 3.5%, textured soya protein 5%, baking powder 0.5%, spice mix 1.75%, condiments 3%, monosodium glutamate 0.25%, rice flour 8.2%, maida 3% and oat flour 3.6% was suitable for processing of good quality meat wafers based on different physico-chemical and sensory quality characteristics. Cold extrusion method followed by microwave cooking was found to be most suitable processing technique.

2. Development of Poultry Meat Finger Chips

Several individual trails were envisaged to optimize formulation for development of shelf-stable poultry meat finger chips. The formulation for meat finger chips optimized containing turkey and spent hen meat (50:50) mince 70%, table salt 1.3%, baking powder 0.6%, spice mix 2.5%, rice flour 13.1%, sorghum flour 6.6% and oat flour 6%. The finger chips were rated very good by the sensory panel members. The microwave method was selected best than cooking methods.

3. Chicken Steaks

The technology for development of restructured chicken steaks utilizing spent hen meat has been standardized. A combination of textured soy protein and milk co-precipitate was found much more acceptable as extender and could be incorporated up to 30% level in chicken steaks' formulation. Packaging and shelf-life studies of the product indicated a refrigerated shelf-life of 9 days for vacuum packaged steaks as against 6 days for those packaged in low density polyethylene (LDPE) pouches. Under frozen storage (-18±1°C) the steaks of both packaging groups could safely be stored up to 60 days, however, vacuum packaged steaks were more acceptable throughout the storage.

4. Mixed Chicken Loaf

Mixed chicken loaf made with dark meat from Kadakanath and broiler meat provided good appearance as well as flavour of indigenous fowl meat to the product. Experiments revealed that loaf prepared by replacement of meat with pulse as a binder and incorporation of 5% hydrogenated vegetable fat was rated good by the sensory evaluation panels. On evaluation of physico-chemical, microbial and organoleptic properties, it was found that the product could be safely stored up to 5 months at freezing temperature (–10°C).

5. Marinated Chicken Breast Fillets

Marination and processing techniques for the development of delicious, heat-and-serve chicken breast fillets have been standardized. The marinade contained cereal starch, common salt, citric acid, polyphosphate and spice mix. The process developed consisted of tumbling of excised broiler breast fillets (Pectoralis superlicialis) with marinade mix slurry and oven roasting. Blade tenderization followed by still marination of fillets for 60 min. produced product with comparable quality as an alternative to tumbling. Vacuum or nitrogen gas packed fillets in aluminium-foil based (PFP) laminated pouches could be safely stored for 3 weeks and 3 months under refrigeration (4±1°C) and frozen (-18°C) storage as against 8 and 45 days long shelf-life of aerobically packed product, respectively.

6. Egg-Meat Patties

Inclusion of meat in egg product formulations is not new to the egg products industry and such products have been found popular in many developed countries. On similar line, egg-meat patties have successfully been developed incorporating minced chicken meat in egg patty formulation. Other ingredients included textured soya flour, spice mix, onion-ginger paste and salt. This highly acceptable product was stable for up to 14 days under refrigeration (5±1°C) and up to 90 days under frozen (-18±1°C) conditions.

7. Chicken Sausage

Chicken sausage production is a good way of utilizing culled/spent hens in more profitable manner. The recipe and methods of preparation have been standardized in the laboratory. Chicken sausage mainly contains 50-60% meat, 7-15% fat and 5-10% binders in addition to extenders, preservatives and seasonings. The finished product cooked by various methods has been rated as highly palatable by

panelist on sensory evaluation trials. The shelf-life of the product is about 7 days at refrigerated temperature (4°C) and 3 months under frozen (-18°C) storage. The product has got a great market potential.

8. Chicken Patties

Chicken patty can be prepared with meat from spent hens. The recipe has been standardized. It has been found from the studies that chicken fat can be used up to 12% in preparation of the product. The pre-cooked patties can be stored for 10 days under refrigeration (4°C) and 60 days in the frozen (-18°C) state.

9. Intermediate Moisture Chicken Meat

An optimum infusion solution and processing technology for the preparation of intermediate moisture chicken meat (IMCM) for storage at room temperature has been standardized. Infusion solution recipe included humectants like common salt, glycerol and cane sugar, trisodium citrate, STPP and sodium benzoate. The process standardized for manufacturing IMCM consisted of a combination of humectants and hurdle technology viz. dipping of dressed chicken in 2% lactic acid dip for 2 min, dicing of meat into chunks, soak equilibration for 12 h in infusion solution and turmeric-garlic paste application prior to 4 h of oven drying (80±2°C). The finished product packaged in flexible-HDPE pouches has a shelf-life of 2 months at mean room temperature (24°C).

10. Chicken Meat Spread

Chicken spread from pre-cooked, deboned and minced spent hen meat (85%) in combination with cereal starch, egg yolk, seasonings and permitted food additives was developed. The process, in brief, consisted of addition of 20% potable water to meat emulsion so as to improving spread ability prior to packaging and thermal processing in hot water bath to an internal temperature of 78±1°C for gelatinization of starch and stabilization of the emulsified product. The product can be safely stored for 12 and 60 days under refrigerated (5±1°C) and frozen (-18°C) storage, respectively.

11. Chicken Gizzard Pickle

Chicken gizzard pickle is a comparatively cheap fast food with prolonged storage stability at room temperature. Small entrepreneurs may be attracted to produce and market the product by meager

financial investment. Gizzard pickle (oil based as well as vinegar based) contained about 22% crude protein and 9 to 10% total lipids with calculated caloric yield ranging from 262 (vinegar based) to 282 (oil based). These pickles can be stored at ambient temperature (34°C) for 45 days during summer and rainy season and for 75 days in winter (26°C).

12. Cooked Chicken Roll

Cooked chicken roll is a novel, ready-to-consume, fast food requiring mild warming before use. Processing is based on cut cost technology without compromising on nutritive value through use of processed/roasted gram flour. The product can be safely stored till 4 weeks under freezing temperature (-18±1°C) and for 2 weeks when kept under refrigeration temperature (4±1°C). Depending upon the mode and place of marketing, the profit may vary from 40 to 60% of the production cost.

13. Spent Hen Meat Block

In order to explore an avenue for the disposal of less preferred spent (culled) hens, a by-product of layer industry, processing technique for preparing comminuted spent hen meat block was standardized. The optimum formulation consisted of 60% minced spent hen meat, 15% skin, gizzard and heart in natural proportion in combination with binders/extenders, edible oil, seasonings and 0.5% polyphosphate. Mild acidulation (0.4% lactic acid) of the meat emulsion appeared beneficial in lowering its pH without imparting perceptible sourness in the product. This treatment resulted in extending the refrigerated (5±1°C) shelf-life of the product up to 15 days as against 10 days for that devoid of added organic acid.

14. Cooked Chicken Stock

It is an instant chicken meat product reconstitutable to curried chicken dish. It can be packed in ordinary, laminated aluminium foil pouches and can be stored upto 14 days refrigerated (5°C) or 28 days under frozen storage (-18°C) conditions.

15. Chicken-Skin Meat Cutlet

Based on utilization of completely de-feathered chicken skin up to 30% (w/w) supplementary level with minced meat, the formulation methodology for processing chicken-skin meat cutlet has been standardized. The product can be consumed till 14 and 28 days of refrigerated (4±1°C) and frozen (-18°C) storage, respectively.

16. Chicken Chunkalona

A process for preparing delicious chicken chunkalona from a combination of minced spent hen meat (60%), pre-marinated tender broiler meat chunks (25%) along with binders, extenders and seasonings was optimized. The product packaged in retortable 3ply laminated (polyester/foil/pp) pouches and then subjected to retort processing (1

kg/cm2; 30 min.) had microbiologically safe and organoleptically acceptable shelf-life of 2 weeks under ambient (25°C) storage.

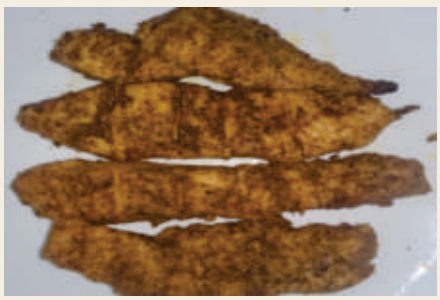
17. Chicken Gizzard Snacks

In order to develop low cost convenient chicken meat products, the cost-effective method of preparing chicken gizzard snacks has been standardized. Such snacks made with 8% water medium garlic extract could be kept for 18 and 35 days under refrigeration (4±1°C) and freezing (-18°C) temperatures, respectively.

18. Poultry By-products based Pet Foods

A simple, cost-effective and efficient process for the conversion of poultry offals into nutritious and highly palatable food for pet dogs has been developed. The process, in brief, consisted of autoclaving of freshly collected and cleaned inedible chicken offals (excluding feathers) plus giblets (heart, gizzard and liver) at 1 kg/cm2 pressure for 30 min. and 10 min. for blood, mincing the autoclaved material and blood coagulum in 5 mm sheath mincer, oven drying (70°C, 16 h), grinding, sieving, addition of 0.02% BHA as antioxidant, packaging in LDPE (300 G) pouches to prepare poultry by-product meal (PBPM). This PBPM at 15% level could be mixed with leaker egg liquid (20%), bakery waste (20%), maize flour (24%), wheat flour (10%), defatted soy flour (5%), soybean oil (5%), common salt (1%) and permitted food additives (0.02% BHA), 0.5% STP, 0.2% citric acid, 0.05% vitamin and mineral mixture to prepare dough of thick consistency. Forced oven drying (100±1°C, 8 h) of about 1.5 cm thick dough spread in stainless steel trays yielded finished rectangular shaped pet biscuits rich in nutrients. The finished product contained about 95% dry matter, 23.7% crude protein, 18% fat, 52% nitrogen-free extract, 4.8% ash, 0.77% calcium, 0.70% phosphorus, 0.82% lysine, 0.51% methionine and 4.2 kcal/g ME. Feeding 100 g of this pet food to adult pet dogs would contribute to 50 to 60% of daily maintenance requirements for ME, CP, Ca, P available lysine and methionine of pet dogs. The cost of this pet food worked out to be Rs 15/kg. Technology for preparing semi-moist intermediate moisture pet food, using humectants, has also been developed for young pups.

19. Breast fillets



Breast fillets processed from using spent chicken which are very tough are more nutritious, tender and highly acceptable than the traditional fillets. The breast fillets can be prepared in microwave oven (grill)/ hot air oven andhas shelf life of 15 days at refrigeration temperature (4±1°C).

20. Poultry Meat Finger Chips

Spent chicken meat (layer bird and breeder birds) can be well utilized to produce this product and may also attract a premium price. Prepared by using turkey and chicken meat. It contains functional ingredients like oat fibre, oregano and basil, apple peel paste and vitamin E which are beneficial to health. Method developed is very simple, only 5-6 min cooking time is required for processing in microwave. Can be stored up to 8 weeks at ambient temperature under aerobic packaging condition.

21. Functional Chicken Sausages

Prepared from culled chicken which is considered waste by the layer industry. Contains less fat, low in sodium content, and also contain Makhana and oregano powder which provide health beneficial effects. Can be stored up to 20 days at refrigeration temperature (4±1 ºC) under aerobic packaging condition.

22. Chicken Tikka

Spent chicken meat (layer bird and breeder birds) can be well utilized to produce this product and may also attract a premium price. Chicken Tikka, a traditional/ethnic meat product of the country was developed using common naturally occurring ingredients. Spent hen meat is tough but will become soft during preparation of this product. Can be stored up to 30 days at 4 °C temperature.

23. Chicken Meat Pickle

It is a popular traditional meat product throughout the country but lacks effective storage life while compared with citrus fruit based pickle. Good quality of chicken meat pickle was developed in our lab using brine dipping methods. Can be stored up to 4 months at room temperature

24. Functional Chicken Meat Bites

Functional chicken meat bites contain spent hen meat and health promoting ingredients (fox nut seed powder, moringa leaf powder and oregano).This product is unique since it is prepared from tough chicken meat and plant based health promoting ingredients, hence has greater potential for marketing and has a shelf life of 20 days at refrigeration temperature (4±1 ºC) under aerobic packaging condition.

II. DEVELOPMENT OF NOVEL VALUE ADDED EGG PRODUCT

1. Baked Egg

Process of preparing baked egg has been standardized. Baked Egg is a nutritious and versatile snack food ideal for the breakfast meal. It offers a potential market at growing fast food outlets. Most acceptable baked egg can be prepared using 70% liquid whole egg, 12% grated cheese and 5% skim milk solids with finely chopped onion, ginger paste, chopped green pepper and salt at 5, 5, 2 and 1% levels respectively. The finished product was also found to have satisfactory microbiological quality. The cost of formulating one processed baked egg of 15.5 cm diameter and 2 cm thickness weighing about 240 g was calculated to Rs. 29.70. The shelf life studies indicated that baked egg was acceptable for 12 days in vacuum and 10 days in aerobic packs at refrigerated storage with satisfactory physico-chemical and microbiological quality.

2. Egg Tikka

Process of preparing egg tikka has been standardized. Egg tikka prepared with coatings containing mashed potato, refined rice flour, bread crumbs, black pepper and salt at 77, 5, 15, 1.5 and 1.5% levels respectively was organoleptically most acceptable and had a refrigerated shelf life of 20 days in vacuum and 18 days in aerobic packaging with satisfactory microbiological and organoleptic quality. The cost of formulating one processed egg tikka weighing about 80 g was calculated to Rs. 5.60.

3. Egg Cutlet

Process of preparing egg cutlet has been standardized. Egg cutlet prepared with 42% egg and 40% minced chicken meat with 6.7% grated cheese, 6.0% onion paste, 2.0% refined wheat flour, 0.10% mustard powder, 2.0 % spice mix, 0.8% salt and 0.2% each of white vinegar and soy sauce was most acceptable and had a refrigerated shelf life of 14 days in vacuum and 12 days in aerobic packaging with satisfactory microbiological and organoleptic quality. The cost of formulating one processed egg cutlet weighing about 125 g was calculated to Rs. 21.70.

4. Albumen Rings

Albumen rings are low fat egg snack food prepared by steam cooking blended egg albumen in ring molds, battering and breading the coagulated albumen and deep fat frying. The ready-to-eat rings contained 11.5% protein and merely 3.2% fat. This product can be safely stored by refrigeration (4±1°C) for 18 days in vacuum and 12 days in aerobic pack.

5. Egg Rings

Egg rings are egg snack food prepared by steam cooking of blended liquid whole egg in ring molds, then battering and breading the coagulated rings and deep fat frying. The batter-breaded rings contained 12.3% protein, 11.2% fat and had a refrigerated (4±1°C) shelf-life of 12 days in aerobic packaging in polyethylene pouches.

6. Egg Pancakes

Egg pancake is a convenience egg-rich product and can be popularized as a complete breakfast meal at homes as well as at growing fast food outlets. Ingredients used for preparing highly acceptable, light, fluffy and spongy pancakes include liquid whole egg, milk, wheat flour, sugar and baking powder. The pancakes had a refrigerated shelf-life of 12 days in vacuum packaging without any detectable deteriorative changes.

7. Egg Patties

Processing methodology and recipe for preparing egg patties has been standardized. The highly acceptable formulation included liquid whole egg, mashed potato, texturized soya flour, non-fat dry milk, spices, condiments and salt. Steam-cooked patties had a refrigerated shelf-life of 14 days in vacuum and 12 days in aerobic packaging, while at frozen temperature (-18±1°C) the product was stable for 90 days in vacuum and 80 days in aerobic packaging.

8. Egg-Crust Pizza

Process of preparing egg-crust pizza has been standardized. The pizza prepared with either foamed all-albumen crust, albumenflour-oil crust or albumen-skim milk solid-oil crust was rated best in sensory quality. The egg-crust pizza base has a refrigerated (5°C) shelf-life of 6 days in vacuum and 4 days in aerobic packaging. This product can be popularized as a meal or snack at fast food outlets.

9. Low-Fat Egg Patty

A low-fat egg patty was developed, especially for health conscious consumers. The formulation ingredients include liquid egg albumen, mashed potato, textured soya flour, non-fat dry milk, salt, spices and condiments. The ready-to-eat fried patties contained 13.6% protein and merely 2.5% fat.

10. Egg Roll

Egg roll is a baked and breaded product with scrambled egg and chicken sausage filling. This product is suitable for either meals or in-between meal as snacks. The most acceptable recipe of egg filling consisted of 80% scrambled egg with 20% ground chicken sausage. This product can safely be stored by refrigeration (5°C) for 8 days in vacuum and 6 days in aerobic packaging.

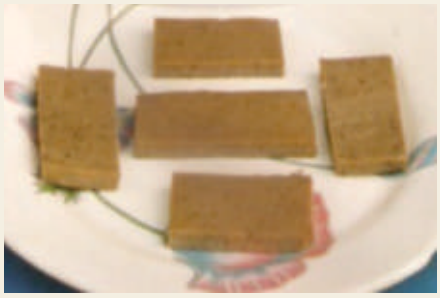
11. Battered Fried Egg

Battered fried egg is a hard cooked peeled egg, moulded with chicken sausage mixture around its plain surface, rolled in fine dry bread crumbs and deep-fat fried. It is a value-added convenience egg product in fast food establishments. Technology for preparing battered fried egg has been standardized. Shelf-life studies have shown that the product was microbiologically satisfactory and organoleptically acceptable for up to 12 days at refrigeration temperature.

12. Pickled Quail Eggs

A simple, cost-effective and efficient technology for the development of ready-to-eat pickled quail eggs has been developed and perfected for commercial exploitation. The process, in brief, consists of hard cooking and peeling of eggs, preparation of vinegar based pickling solution or oil-based pickle gravy, seasoning and packaging in flexible/laminated thermoplastic pouches without the pickling solution. The product can be safely stored for about 4 months at room temperature and a year under refrigeration (5°C). The shelf-life of pickled eggs could be extended upto 8 months at room temperature under nitrogen gas packaging in laminated pouches.

13. Egg Strip



Egg strip is a nutritious and versatile snack food ideal for person of all ages. It is made from blended liquid whole egg combined with soya protein and spices. Egg strips are stable for 16 days in vacuum and 10 days in aerobic pack at refrigeration temperature (4±1°C) with a formulation cost of Rs. 40/- per kg.

14. Stuffed and Coated Egg

Processing techniques for preparing nutritious and delicious stuffed and coated egg have been standardized. The hard-cooked and peeled chicken egg was cut in half along the long axis, yolk removed, hallow of each half was filled with yolk and chicken meat mixes and wrapped in a thin layer of chicken meat emulsion and deep fried. The refrigerated (4±1°C) shelf-life of stuffed and coated egg was 18 days in vacuum and 16 days in aerobic pack.

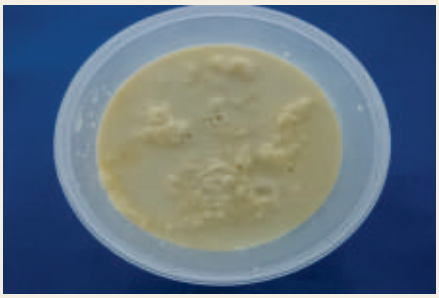
15. Egg Waffles

Process of preparing egg waffles was standardized. Egg waffles prepared from liquid whole egg, wheat flour and granulated wheat had an ambient shelf-life of 4 days in vacuum and 3 days in aerobic pack as against 10 and 6 days in respective packs at refrigeration temperature.

16. Low Sodium Salted Chicken Eggs

A simple technique for preparation of intact low sodium salted chicken shell eggs has been developed which obviates the need for using salt with low level of sodium prior to serving boiled eggs and hence a convenient product for egg vendors.

17. Egg Rasmalai



It is a nutritious and delicacy item for all age groups of people. In preparation, shell eggs are broken in a bowl and mixed well with milk powder until desired consistency achieved. On the other hand raw milk is heated in a pan and after generous heating sugar is added. The batter prepared previously is fall on heated milk as lumps which were then heat slowly. After completion of cooking cardamom and essence are added and chilled for two hrs before serving. This product contains less fat but higher protein content than traditional Rasmalai and can be stored up to 7 days at refrigeration temperature (4±1 ºC) under aerobic packaging condition.

18. Instant Emu Egg Noodles

High nutritional value with vitamins and essential amino acids that is lacking in cereal based noodles. Can be stored for 3 months at room temperature under aerobic packaging condition.

19. Chicken Egg Sausages

Highly nutritious and tasty delicacy that can be stored for 12 days at 4˚C temperature.

20. Salted Chicken Eggs

A simple product for preparation of intact salted chicken shell eggs. No need to add salt after boiling.

21. Oat Flour Based Egg Biscuits

High nutritional value, of oat and to enhance the functionality of liquid whole egg, formulations suing oat flour have been standardized in combination with liquid whole egg.

22. Malted Barley Flour Based Fermented Chicken Meat Sausages

Chicken meat sausages is made from fermented minced chicken meat using Lactobacillus plantarum with malted barley flour. The fermented chicken meat sausages have better functional attributes in terms of higher antioxidant potential, high fiber content and better sensory profile as compared to non-fermented chicken meat sausages. The product also indicated better functional attributes towards lowering blood glucose and serum cholesterol levels in the animal feeding trials involving mice.

23. Functional Chicken Seekh Kebabs

Spent hen meat has been standardized to enhance the functional attributes and also to increase shelf-life of Chicken Seekh Kababs which is a popular traditional chicken meat product. The formulation has greater antioxidant and antimicrobial activity and also effectively delays lipid oxidation. The product has better sensory acceptability and the extended shelf life of 21 days at refrigeration storage.

24. Bone-in Chicken Pickle

With an aim to store chicken meat for longer duration especially under rural set up and also without using refrigeration facility, a processing technology for formulation of bone-in chicken meat pickle was prepared using brine dipping method so as to keep product for longer duration. The process includes mixing gravy with pre-fried meat chunks, cooled to room temperature and held at 27±2ºC for maturation and subsequent storage. Shelf life: Max. 3 months at ambient storage.

III. Tenderization of Spent Hen Meat

In order to improve the marketability of spent hens/ culled breeding stocks, whose demand is on the decline due to toughness of their meat, carcass fatness, a simple technique for the tenderization of such tough meat has been evolved. The process standardized consists of soaking of eviscerated spent hen/culled breeding stock carcass for 3 h in 0.05% papain or 0.075% trypsin in combination with 1.0% sodium chloride and 0.05% sodium tripolyphosphate. This tenderization method is superior to the cumbersome and commercially impracticable intravenous or intraperitoneal injection of enzymatic solution prior to slaughter of birds.

Avian Biotechnology

1. Development of Transgenic Spermatozoa

Chicken may be an excellent model to be used as bioreactor to produce proteins of pharmaceutical importance through transgenesis. The multi-cellular stage of embryo in freshly laid egg, breaking of the egg shell to get access to embryo and the presence of large amount of yolk are certain hurdles in developing transgenic chicken, unlike in mammals. However, sperm mediated gene transfer method may be the method of choice for transgenic chicken production and developing transgenic sperm is first crucial prerequisite.

A simple method of integrating the foreign DNA into spermatozoa genome has been developed and optimized. Protocol briefly includes separation of spermatozoa from semen through centrifugation, washing of spermatozoa with washing buffer and its subsequent dilution of spermatozoa in a fixed concentration in a suitable buffer. A foreign DNA (gene to be integrated) plus liposome mixture is prepared by mixing them in certain proportion and incubation at room temperature. Similarly, a restriction enzyme (NcoI) and liposome mixture is prepared by mixing both in a fixed concentration and room temperature incubation. Subsequently, both the mixtures are mixed and resultant admixture in incubated for a fixed duration at room temperature. It can be used to inseminate the hens.

2. Estimation of Parental Genomic Proportion in Progenies using Microsatellite Markers

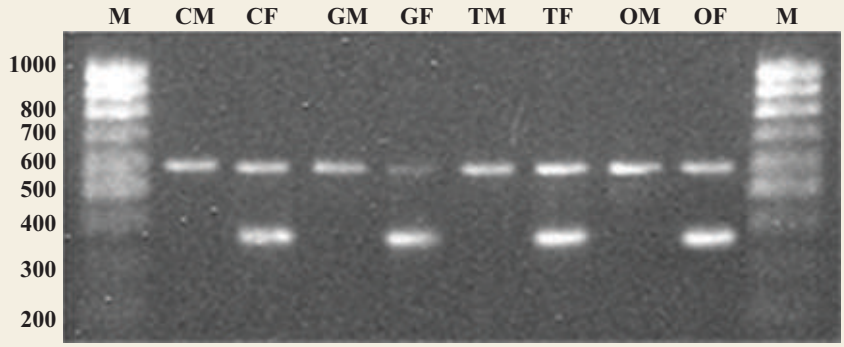
Offsprings receive half of the genome from each parent i.e., 50% from dam and 50% from sire. Since, the DNA markers are the part of genome, hence the offspring inherit these markers also as a part of genome and the markers come from father as well as mother side. Hence, the proportion of a particular parent in offspring can be judged from the proportion of the markers in the offspring, specific to that particular parent and this proportion of markers may be expressed as proportion of common band sharing between the parent(s) and offspings, which will in turn, reflect the genetic similarity between them.

The basic protocol includes identification of polymorphic microsatellite markers, isolation of genomic DNA from the parent(s) and offsprings to make a panel of genomic DNAs,; PCR amplifications using this panel of genomic DNAs for each microsatellite markers, resolution on metaphor agarose, sizing of the alleles and estimation of proportion of the common alleles at each markers as well as cumulatively on all markers. This cumulative proportion of common bands will show the genetic similarity between parent(s) and offspring and may range from 0 to 1. Higher the proportion, higher will be the parental genomic proportion.

3. Multiplex PCR for Sex Differentiation in Guinea Fowl

In avians, females are the heterogametic sex (ZW) while males are the homogametic sex (ZZ). Hence, the W chromosome specific sequences/genes may provide an effective way for sex differentiation using PCR based methods. Major problem faced with W

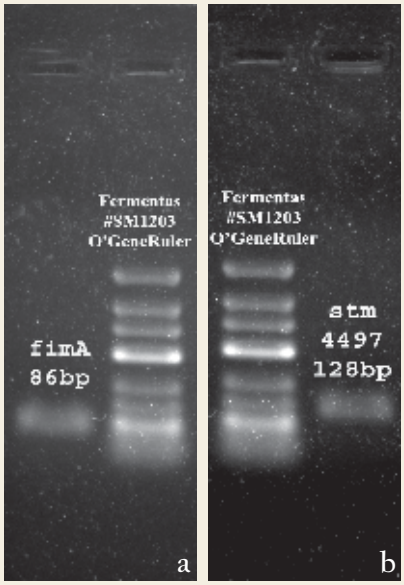
chromosome specific sequence based PCR methods is to differentiate between the no amplification in males with PCR failure. Hence to amplify a common band in both the sexes and female specific band only in female simultaneously is the best method to overcome this problem. Thus, using a set of primers i.e., USP1 and USP3 specific to W Chromosome 0.6 kb EcoRI fragment, hence specific to females and another set of primers i.e., DS1 and DS2, specific to partial 16S rRNA gene, hence common to both, a multiplex PCR was developed. In guinea fowl, female will show 2 bands i.e., 370 bp female specific and 590 bp common bands, while males will show only 590 bp band. This method will be used in sex differentiation in guinea fowl at day old age, as sexual bi-morphism is very poorly defined in this species



Amplification of two bands i.e. 370 bp and 590 bp in females and one band i.e. 590 bp in males.
CM: Chicken male, CF: Chicken female, GM: Guinea Fowl male, GF: Guinea Fowl female
QM: Quail male, QF: Quail female, TM: Turkey male and TF: Turkey female;
M: Molecular size marker-100bp DNA ladder)

4. Detection of Salmonella typhimurium using Serotype Specific Primers by PCR

Salmonella is a bacterial pathogen of zoonotic significance of poultry origin with *Salmonella typhimurium* as the predominant serovar. Conventional culture methods being cumbersome and time consuming therefore there is need for rapid and sensitive detection of pathogen using PCR based technique. Serovar specific primers were designed with an aim to detect specifically *Salmonella typhimurium* serovar from poultry and poultry products. In our method the detection of *Salmonella typhimurium* depends upon the amplification of fimA and stm4497 genes with serovar specific primers with amplicon size of 86bp and 128 bp, respectively.



Amplification of fimA (a) and stm4497(b) genes

5. Biochemical Basis for Detection of Calpains and Calpastatin and their Role in Post-mortem Tenderization of Meat

Simple and low-cost casein zymography method is developed for rapid determination of µ- and m- calpain enzymes from variety of tissue samples of poultry species. It was observed that the µ-calpain is greatly influenced the post-mortem ageing of meat from different species, breeds, sex and age of animals; however its concentration declined with the increase of ageing periods. The calpains and calpastatin levels were higher in muscle samples than that found in blood samples, and further, calpastatin concentration in some species up to 2 - 3 times higher than µ-calpain. Thus determination of µ-calpain and calpastatin concentrations in blood could help in prediction of µ-calpain-induced post-mortem ageing of meat, since there is a strong correlation of enzyme concentration found in blood and distribution in muscle samples, but are species/ breeds/ sex/age specific. Further, it has been observed that though substantial amount of µ-calpain was found on biochemical assay but it did not show activity when performed casing zymography analysis.

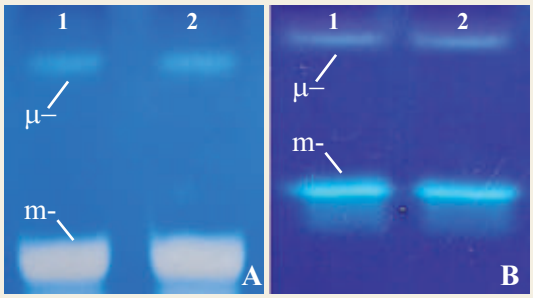


Fig. 1 Identification of calpains in RIR and Broiler breeder muscle samples:
(A) Casein zymography: Lane-1: Breast muscle; Lane-2: Thigh muscle.
(B) Casein zymography: Lane-1: Breast muscle; Lane-2: Breast muscle.

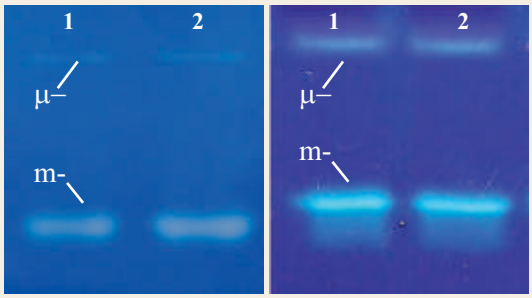
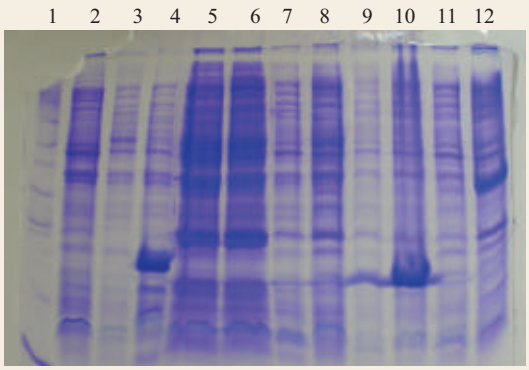


Fig. 2: Identification of calpains in RIR and Broiler breeder blood samples:
(A) Casein zymography: Lane-1: RIR blood; Lane-2: RIR blood.
(B) Casein zymogram: Lane-1: Broiler blood; Lane-2: Broiler blood.

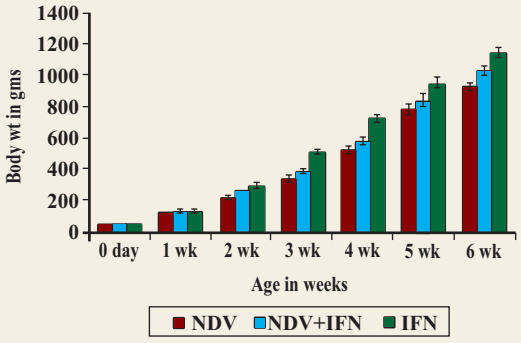
6. Recombinant Cytokines Production and their use as Adjuvant and Growth Promoter

In order to improve the marketability of spent hens/culled breeding stocks, whose demand is on the decline due to toughness of their meat, carcass fatness and increased availability of broilers, a simple technique for the tenderization of such tough meat has been evolved. The process standardized consists of soaking of eviscerated spent hen/culled breeding stock carcass for 3 h in 0.05% papain or 0.075% trypsin in combination with 1.0%

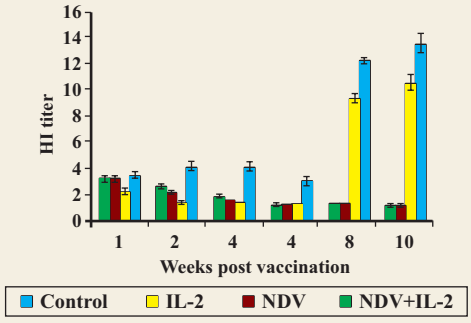


1.Page Ruler; 2. BL-21; 3. Uninduced Lymphotactin; 7. Uninduced chCCLi2; 9. Uninduced IFN-γ; 11. Uninduced IL-2
Polyacrylamide gel showing expression of recombinant cytokines

sodium chloride and 0.05% sodium tripolyphosphate. This tenderization method is superior to the cumbersome and commercially impracticable intravenous or intraperitoneal injection of enzymatic solution prior to slaughter of birds.



Polyacrylamide gel showing expression of recombinant cytokines



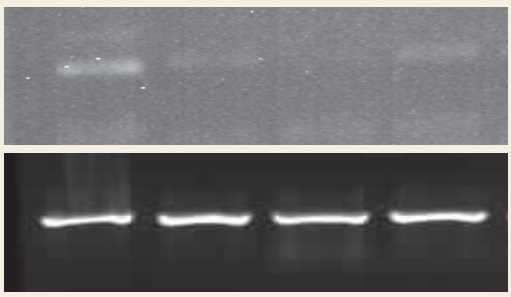
Assessment of growth promoter property of rChIFN-λ in broilers

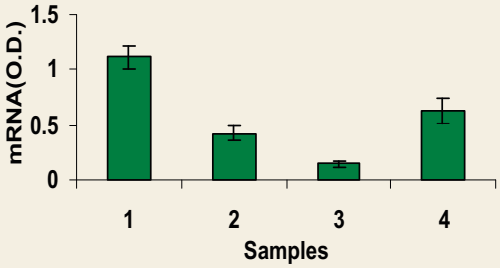
7. Molecular Marker for Immune Response to Newcastle Disease Virus (NDV)

Identification of molecular marker for enhancing protection has been a constant pursuit of poultry geneticist. The SNP (A318G) in IFN- promoter region was found to be associated with immune response to NDV. Allele -318G was identified as molecular marker for improving immune response to NDV.A simple procedure applicable in commercial breeding program without hi-tech laboratory facilities for increasing the frequency of -318G allele in population and thereby improving the ND vaccine response was developed.

8. Silencing of Myostatin Gene in Cultured Chicken Embryo fibroblast

The biotechnological tools are envisaged to have the potential to overcome physiological barriers for increasing muscle development. The application of RNAi for silencing myostatin gene was a step forward in this direction. siRNAs for myostatin were designed and procedures were developed for silencing myostatin gene in cultured chicken embryo fibroblast.





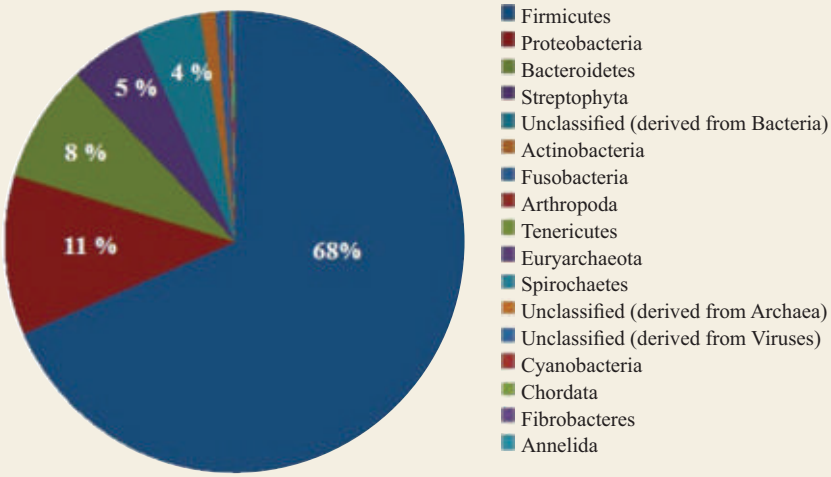
1. GMEM Control
2. *siPORT* lipid Control
3. *siPORT* lipid + siRNA(2) Amine + siRNA (2)
4. *siPORT*TM

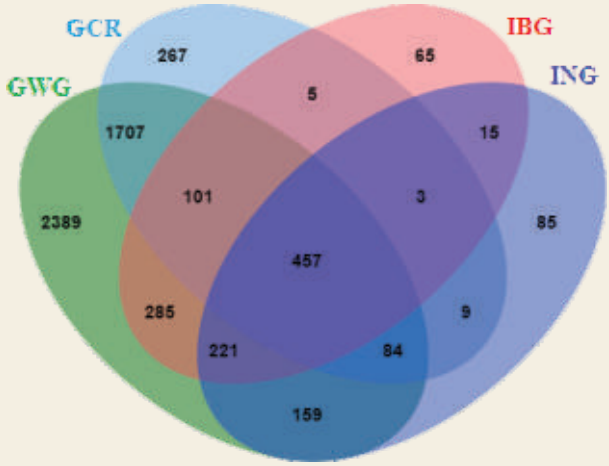
Estimation of myostatin expression in cultured CEF in siRNA experiment

9. Isolated and Identified the Host Specific Lactobacillus from the Gut of Diversified Poultry Species as a Probiotic Candidate

Probiotics are known to benefit the birds by improving their intestinal microflora balance. Next Generation Sequencing (NGS) based analysis of gut microbial profile in Guinea fowl and Red jungle revealed the presence of several isolates that have probiotic potentially. A total of 4528 unique host specific isolates were observed in guinea fowl of which LGFCP4 and LGFP16 shared *Lactobacillus reuteri* with *Lactobacillus plantarum* and *Lactobacillus reuteri*. LRJFCM30 in red jungle fowl, shared 93% genetic identity with *Lactobacillus reuteri* through BLAST analysis. *In vivo* bioassays in broilers revealed that supplementation of laboratory isolated *Lactobacillus reuteri* @ $1x10^8$ cfu/g/day, in combination with 0.1% manan-oligosaccharide (MOS) improved ($P<0.05$) production and immunological traits.

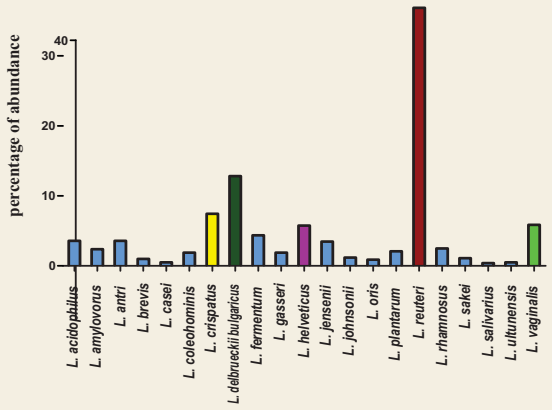
In vivo bioassays in broilers revealed that supplementation of laboratory isolated *Lactobacillus reuteri* and *L. plantarum* @ 1×10^8 cfu/g/day, in combination with 0.1% MOS improved ($P<0.05$) feed efficiency and enhance immunological profile. This technology allows the possibility of extrapolating this probiotic as potential alternative to antibiotic growth promoter.

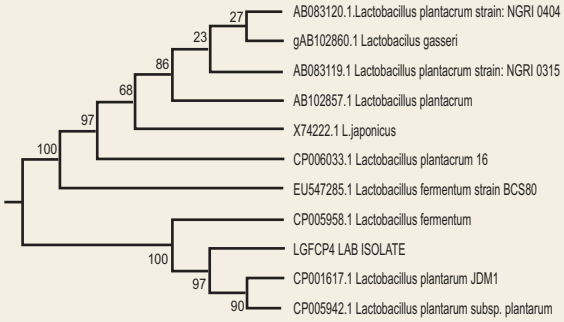




G GWG: Guinea fowl GIT in intensive system
GCR: Guinea fowl Crop in intensive system
IBG: Broiler GIT in intensive system
ING: CARI-Nirbheek gut in intensive system
G: Guinea fowl GIT in intensive system
GCR: Guinea fowl Crop in intensive system
IBG: Broiler GIT in intensive system
ING: CARI-Nirbheek gut in intensive system

***Lactobacillus* species abundance in the crop of Guinea fowl**





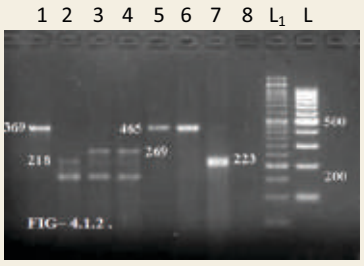
Phylogenetic tree for 16 S rRNA-23S rRNA ISR sequences

10. Molecular Markers to Differentiate Domesticated and Wild Quails

The present technology is developed to provide molecular differentiation and identification of domesticated Japanese quail from wild quail where species differentiation between Japanese and wild quail based on morphological trait is not unequivocal. In India, restrictions exist with sustainable quail farming owing to Wildlife Protection Act, 1972. Because this species is still considered among the wild quail (exception given in the recent gazette) and its farming is restricted by Ministry of Environment and Forests. Enrichment of short tandem repeat rich region in whole genome by biotin labelled tandem repeats probes followed by Next generation sequencing (ion torrent) is a cost effective and less time consuming approach for species specific microsatellite marker identification. The quantity of markers identified by this technique is very high compared to other conventional methods of microsatellite marker identification. Around 10 and 9 polymorphic markers with more than 3 alleles were genotyped and selected as markers in domesticated and wild Japanese quail populations.

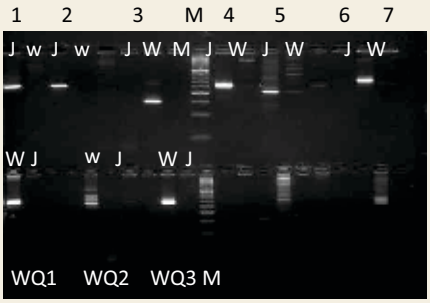
J. Quail

Wild Quail



mtDNA analysis

1. J. Quail 2. Wild Quail 3. SDL 4. Kadaknath
5. Turkey 6. Guinea fowl 7. Peafowl
8. Emu, L1 and L2 – 50 and 100 bp Markers



STR Markers identified by whole genome analysis

Feeding and Feed Resources

1. Updating Nutrient Requirements

The requirements and bioavailability of dietary nutrients e.g. protein, energy, amino acids, certain limiting minerals and vitamins for different classes of poultry such as meat and egg type chicken, quails, guinea fowl, turkey, etc. are being updated regularly with the change in genetic potential of birds. The dietary interrelationships of energy and protein; lysine and methionine; vitamin D3, calcium and phosphorus; zinc and manganese; zinc and copper, zinc and vitamin A, selenium and vitamin E, lysine, folic acid and biotin, etc. have been established. It has been feasible to reduce dietary protein requirements of growing chicks, laying hens, broiler chickens, growing and laying Japanese quails and turkey poults to improve nitrogen utilization efficiency and feed-cost efficient poultry production through precise supply of critical amino acids. The comparative efficacy of DL-methionine and methionine hydroxyl analogue has been established in the diet of broiler chickens and Japanese quails for growth, feed conversion, immunity and as an antidote of aflatoxins. The requirements for broiler chickens and growing and laying quails have been successfully partitioned for developing feeding standards. The dietary energy, protein and essential amino acid profile of broiler chickens at high altitude of Mukteswar have been established. These recommendations are being used by poultry farmers, feed manufacturers, researchers, Bureau of Indian Standards (BIS) and ICAR feeding standard (2013).

2. Alternate Feed Resources

India, due to its highly variable landscape and agro-climate, produces large number of raw materials for feeding. The database of nutritive and feeding value of alternate feed resources such as sunflower seed meal, maize gluten meal, rapeseed/mustard oil meal, rice bran, wheat bran, guar meal, cotton seed meal, tapioca, sunflower cake, niger meal, millets, molasses, apple pomace, broken rice, neem seed kernel, etc have been developed. Besides this, low cost feed formulae is successfully developed for various poultry by incorporating alternate feed resources such as nutritious cereals and agro-industrial by-products. Several ingredients in the category of nutritious cereals such as sorghum, pearl millet, finger millet, small millets, undersized wheat and rice kani, and residues such as rapeseed meal/mustard oil cake, neem seed cake, karanja cake, cotton seed meal, sesame meal, groundnut meal, sunflower seed meal, safflower seed meal, toasted guar meal, high protein toasted guar korma, niger meal, azolla meal, maize germ meal, etc. have been tested alone or in combination for their feeding value and effective utilization in poultry rations. Certain low cost feed formulae developed incorporating nutritious cereals and oilseed residues were tested through on farm trials at farmers' doors with encouraging results. The recommendations on the nutritive value and safe levels of alternate feed resources are being used by the farmers and industry, and also for updating MakeFeed Poultry software.

3. Augmenting Mineral Bio-availability

Utilization of zinc and copper was realized better from organic sources (propionate) than their inorganic (sulphate) counterparts. The methodology for production of copper methionine (an organic copper supplement with 17% Cu) has been standardized and feeding of such copper chelate at the rate of 100 mg/kg diet was more effective in improving growth, feed conversion, immune-competence and carcass traits and reduction of serum cholesterol in broiler quails than inorganic supplements.

4. Application of Biotechnology and Feed Additives

The nutritive value of feedstuffs has been augmented through various physical, chemical and biological treatments like water washing, wet processing (reconstitution with or without enzymes), dry processing (acidified sodium chlorite treatment for feed hygiene), roasting, autoclaving, alkali and acid treatments, fungal treatment and fermentation of the feed ingredients. Addition of microbial phytase in diets of broiler chicks, egg type chickens, guinea fowl and quails improved phosphorus utilization significantly that provided scope to reduce costlier di-calcium phosphate supplementation. Enzyme supplementation was also found beneficial to improve utilization of sunflower seed meal, maize- finger millet or maize-sorghum based broiler starting and finishing diets. The solid substrate fermentation technique using *Pleurotus sajarcaju* improved the nutritive value of quail droppings. Similarly, using *Aspergillus niger* improved the nutritive value of toasted guar meal, sunflower seed meal, deoiled rice bran and wheat bran. The role of dietary supplementation of mineral chelates, prebiotics and probiotics, organic acids, feed sanitizers and feed enzymes in enhancing the performance and immune response of poultry has also been established. The safety aspects and feeding value of various genetically engineered crops (Bt cotton, Bt rice and quality protein maize) have also been established.

5. Detection and Amelioration of Anti-nutritional Factors and Mycotoxins

Implications of anti-nutritional factors, fungal toxicants and pesticide residues in various feeds and their effective amelioration remedies in the processes of safe food production have been explored. The tolerance levels of dietary aflatoxins in various types of chicken were determined as follows:

White Leghorn chicks	:	150 ppb	Coloured broiler chicks	:	150 ppb
Broiler chicks	:	100 ppb	Quail starter chicks	:	300 ppb
Guinea fowl keets	:	1000 ppb	Quail layers		300 ppb
Turkey	:	50ppb			

Increasing dietary protein, addition of methionine, methionine hudroxy analogue or choline, vegetable oil (with enhanced levels of Vitamin E and choline), ascorbic acid, butylated hydroxyl toluene, sodium bentonite, activated charcoal, diatomaceous earth, hydrated sodium calcium alumino silicate (HSCAS), BHA, selenium, zinc, mannan oligosaccharides, dried yeast were found to alleviate the toxicity of aflatoxins. A combination of sodium bentonite, zeolite and diatomaceous earth @ 0.33% ameliorated the adverse effect of aflatoxins. The different organic acids (propionic acid, benzoic acid,

fumaric acid, citric acid, and tartaric acid) were tried with encouraging results for prevention of mould growth in mixed feed. Dietary supplementation of ginger (*Zingiber officinale*), amla (*Emblica officinalis*) in combination of 1.5% level with 0.5% fructo-oligosaccharide (FOS) counteracted the ill effects of mycotoxicosis (combined effect of aflatoxin B1 and ochratoxin A) in broiler chickens by improving micro-flora, gut health and immune-competence. It also increases the short-chain fatty acids such as butyric acid in the poultry gut, which supports a healthy gut wall.

Fructo oligosaccharides (FOS)

Amla powder

Ginger powder

The tolerance levels of dietary fenvalerate (FEN) and methy parathion (MPA) were established as 50 and 20 ppm in the diet of broilers. Activated charcoal (0.25%) was able to avert the toxicity of 100 ppm FEN in broilers and partially effective in protecting performance of broilers against 25 ppm MPA in diet. Supplementation of TOXORB @ 2 g/kg in diet containing 50 ppm fenvalerate and 25 ppm methyl-parathion insecticide was found effective in averting the adverse effect of these insecticides in broiler chickens. The supplementation of TOXORB was found to be beneficial in averting the adverse effect of fenvalerate and methyl-parathion insecticides in quail chicks.

6. Computer Softwares for Feed Formulation

Make Feed Poultry comprehensive feed formulation softwares, developed by combining the expertise, knowledge and standards of recent technologies are very useful for poultry. It is window based unique softwares for efficient balanced formulation of feed for a wide variety of poultry birds like layer and broiler chickens, quails, guinea fowls etc. Make Feed is a user-friendly and persons having little computer knowledge can utilize it effectively. It provides information on nutritive values for a wide range of feed ingredients along with the maximum inclusion level for each ingredient. The users have options to edit the complete database of feed ingredients and modify suitably, add or delete particular feed ingredient due to change in nutritive composition and availability of feed ingredients.

The cost of the software package is ₹ 3500/- only for Make Feed Poultry, which includes the compact disc containing the software and a comprehensive user manual. For purchase send a demand draft of ₹ 3500/- in favor of the Director, CARI, Izatnagar-243 122, U.P. payable at State Bank of India, CARI Branch (Code 7027). Also provide detailed address for sending through post and our record.

7. Quality Assurance and Analysis of Feeds and Feedstuffs

The Nutrition Division is equipped with well furnished laboratories with modern equipments. Various feed ingredients and compounded feed/concentrates received from the industry, government agencies and farmers are being examined for proximate principles, minerals, adulterants and toxicants.

Rates for feed analysis

Sl. No.	*Tests*	*Rate/test (₹)*
1.	Moisture	50/-
2.	Crude protein	100/-
3.	Crude fibre	100/-
4.	Ether extract	100/-
5.	Total ash	65/-
6.	Acid insoluble ash (Sand and silica)	120/-
7.	Calcium	100/-
8.	Total phosphorus	100/-
9.	Complete analysis (Sl.No.1 to 8)	600/-
10	Common salt (sodium chloride)	120/-
11.	Non-protein nitrogen	180/-
12.	Urease activity	180/-
13.	Tannins	180/-
14.	Glucosinolates	220/-
15.	Aflatoxin B1	220/-
16.	Zinc	130/-
17.	Manganese	130/-
18.	Iron	130/-
19.	Copper	130/-
20.	Protein Digestibility	250/-
20.	Protein Solubility	250/-

- The analysis report is made available within a week from the date of receipt of the feed sample along with demand draft.
- Minimum amount of 100 g of feed sample is to be sent in sealed cover.
- If analysis report is required to be sent through Speed Post/Courier, an additional amount of ₹ 50/- may be added. Reports also be sent through fax or e-mail.
- The analysis report is not valid for legal purpose.

8. Safe Broiler Meat Production

Different prebiotics (MOS and lactose), probiotics (*Bacillus subtilis*, *Lactobacillus* and

Supplementation of 125 mg Cu/kg diet as copper sulphate proved effective in reducing the egg yolk cholesterol content by 18%, while 24% by supplementing layer ration with 300 mg Cu/kg together with 3200 µg chromium per kg diet. The supplementation of Atorvastatin 0.03%+Niacin 375 ppm+ethylene diamine-tetra acetic acid (EDTA) 0.5% in diet of laying

Mannan oligosaccharide (MOS)

Lactobaccilus acidophilu

hens reduced egg yolk cholesterol content up to 35%. Addition of fish oil or spirulina also enriched omega-3 fatty acids in eggs. Dietary supplementation of a combination of organic chromium (chromium picolinate) (1 mg/kg) and spirulina (2 g/kg) reduced egg cholesterol by about 20%. Use of dried ginger and garlic powder in combination reduced egg cholesterol content significantly after four weeks of feeding without affecting production performance in laying quails. Maximum egg yolk cholesterol reduction (24.89%) was recorded in diet containing 0.25% ginger and 3% garlic. The effect of ginger in lowering egg cholesterol was quicker and also lasted for longer period than garlic. Similarly, supplementation of copper at 100 mg/kg diet in laying quails reduced egg yolk cholesterol and serum cholesterol by 19 and 27%, respectively.

Naturally occurring antioxidant-Vitamin E or alfa-tocopherol has been reported to be effective in improving self-life of poultry meat and meat products through delaying lipid oxidation. Dietary supplementation of Vitamin E @ 300 mg/kg diet during last 10 days or 150 mg/kg diet during last three weeks of age (3-6 weeks of age) improved self-life of poultry meat before slaughter. The role of dietary selenium (Se) in influencing the poultry meat quality has also been established. Supplementation of prebiotics (MOS) and probiotics (*Bacillus subtilis*) in diet improved microbiological meat quality. Inclusion of dietary copper @ 200 mg/kg diet improved growth performance and reduced serum cholesterol in broiler chickens.

10. Climate Resilience Poultry Production - Dietary Approaches

Addition of dried fresh root powder of sarpagandha (*Rauwolfia serpentina*) 0.1 to 0.3% or ashwagandha (*Withania somnifera*) 0.2% or dried stem powder of geloi (*Tinospora cordifolia*) 0.1% or dried amla (*Emblica officinalis*) fruit powder 0.2% improved performance (assessed through HL ratio, immuno-competence and oxidative profile) of coloured broiler chickens during peak summer in North India. Supplementation of ascorbic acid @ 150

mg/kg, chromium picolinate 20 mg/kg, Zinc @ 48 mg/kg (total dietary zinc 98 and 96 mg zinc/kg) or potassium chloride 300 mg/kg diet improved performance (body weight gain, feed conversion efficiency, eviscerated and breast yield), welfare (immuno-competence, electrolyte balance, oxidative enzymes profile) and heat stress (relative expression of HSP70 in liver and jejunum) during extreme hot (April – May, shed temp. 31±0.80 to 35±1.20C, Rh, % 59.1±1.2 - 69.6±0.9) and hot-humid (July- Sept, shed temp. 25.8±0.310-33.2±0.370C, Rh,%: 85.3±0.7 - 77.0±0.9) summer in North India. Feed conversion efficiency improved further at 300mg level of ascorbic acid during hot-humid summer. Moreover, potassium chloride was more beneficial in hot-humid summer than in dry hot summer. Also nutritional supplements like Vitamin E @ 150 mg/kg, Aspirin 500 mg/kg, MOS 0.3%, $MgSo_4$ 1.2g/kg had beneficial for broilers raised during dry or hot humid summer for feed-cost effective production and improved humoral immune response. Supplementation of 0.1% betaine improves breeder production and broiler's performance as well as welfare during hot summer.

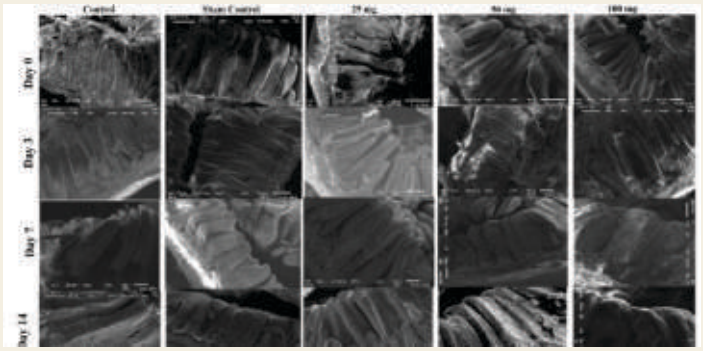
11. Novel Feed Additives Standardized for Enhacing Production Efficiency in Broilers

A variety of formulations have been standardized for use as potential alternative to antibiotic growth promoters (AGPs) under normal and stressed conditions in broiler chickens. Inclusion of *Kappaphycus alvarezii* and red sea weed based formulations at 1.50% level in layer diet reduces age of sexual maturity, improves the production as well as immune response while 1.25% level in broiler diet improves performance, immunity & gut health with reduction of microbiological counts in fresh and storage meat. Nucleosides are the essential nutrients, which can play positive roles in broiler productivity in the tropical areas. Nucleosides feeding (in vivo (0-14 days) or 10 mg/egg *in ovo*) enhance rapid growth rate of gut and body during first 3 wk period, mineral retention, protein synthesis, overall immunity & growth of *Lactobacillus* spp. in intestine. Supplementation of "Postmetabolites" (postbiotics) extracted from *Lactobacillus plantarum* at 0.6% is beneficial for improving production, immunity and gut health in broilers. Dietary supplementation of selenium, zinc and copper nano formulation at 80, 0.25 and 16 ppm is beneficial for enhancing productive efficiency and carcass yield and quality under normal and heat stressed conditions.

12. Standardized Phytobiotic Based Formulations

Inclusion of powder derived from Moringa, Guava, Beal and Curry leaves at 2, 1.5, 2 and 1% respectively is beneficial for enhancing overall broiler production, physiological and immunological indices. Inclusion of 0.2% hempseed and 0.1% dill seed powder in the diet was beneficial for improved growth and welfare of broiler chickens. Dietary supplementation of Tamarind seed polyphenol (TSPE) @ 250 mg / kg diet improved the

immunity, antioxidant properties of meat, as well as decreased fat and cholesterol in broiler chicken ameliorating heat stress and economical broiler production during hot dry



Pattern of intestinal villi development under SEM

Physiological Interventions for enhancing Reproductive and Productive Performance in Poultry

1. A New Selection Parameter for Improvement of Egg Number and Size

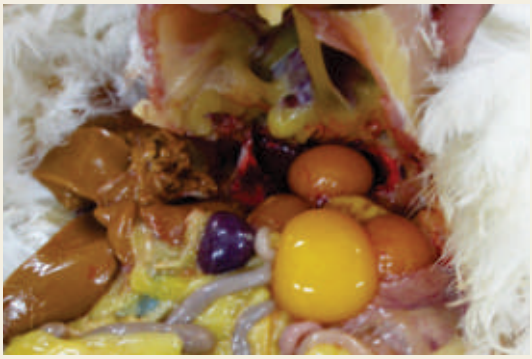
The search for a quick method to improve both egg number and size is the basic necessity of the poultry breeder. This new approach is likely to speed up the process of selection. It is revealed through exhaustive in depth research that leutinizing hormone (LH) receptor cascade maturation rate determines the laying intensity and has got a strong association with rapid phase of yolk deposition, which is an easily monitorable parameter. Birds with short maturation phase has the highest intensity of egg potential. This phase varies in hens anywhere from 5-11 days. This determination work on the fact that liver synthesizes the yolk precursors which enters in circulation and around this time exogenous fat-soluble black dye either administered through feed or intra venous injection absorbed in the lipid component of yolk precursors and then transferred in to yolk growing follicles thus serving as a surveilable indicator of laying flocks. The presence of black colour at the periphery and centre of the laid eggs is considered to govern the duration of rapid phase of follicular growth. Further, the major difference in deposition of yolk take place in last 24 to 48 hr. Besides, the size of yolk determines the egg size. Hence shortest phase coinciding with maximum yolk deposition in preceding 24/ 48 hours to ovulation can be readily used to identify those hens having best possible laying intensity with optimal egg size. This parameter is recommended for evaluating the genetic laying potential of a hen within fortnight instead of part period (40 weeks of age) or full year recording of eggs for selection purpose. Moreover, it allows better screening of female at initial phase of laying itself.

2. Cause of Internal Laying Revealed

Earlier studies have reported about 30% incidences of internal laying in birds during the start of lay period. Such laying anomalies may have aggravated in modern breeds particularly in broilers strains due to heavy selection pressure for rapid growth as the negative association exists between growth and reproductive traits. In view of this fact and considering the escalated cost of day old broiler chicks, a concerted focus was set to probe the cause of such malfunction in order to tackle this sexing problem. Around the age of sexual maturity in broiler breeder hens, the egg production traits, ovarian and oviduct status, endocrine and molecular profiles were assessed by following standard tools to unravel the cause of this reproductive anomaly.

Findings reveal a drastic escalation of internal laying over 45% in modern broiler strain. The average number of hierarchal yellow follicles and the hens with double hierarchy was found more in internal layers as compared to normal birds. In modern strains, it is likely that increased facilitatory recruitment of yellow follicles into growth cycle might have some role in predisposing to this problem of internal laying. A main culprit for internal laying at endocrine level was noted a significant drop in 17-b-estradiol: progesterone ratio as against healthy normal laying birds. At molecular level, in the infundibular tract of hens, to be a significant drop regulation of receptors for progesterone

(0.459), 17-β-estradiol (0.258) and testosterone (0.673) were recorded in internal layers as compared to normal birds. In double yolk (hierarchy) bearing hens, which were more prone to internal laying problems, a significant down regulation of progesterone (0.555), 17- β-estradiol (0.217) and testosterone (0.530) was also recorded as compared to normal laying hens.

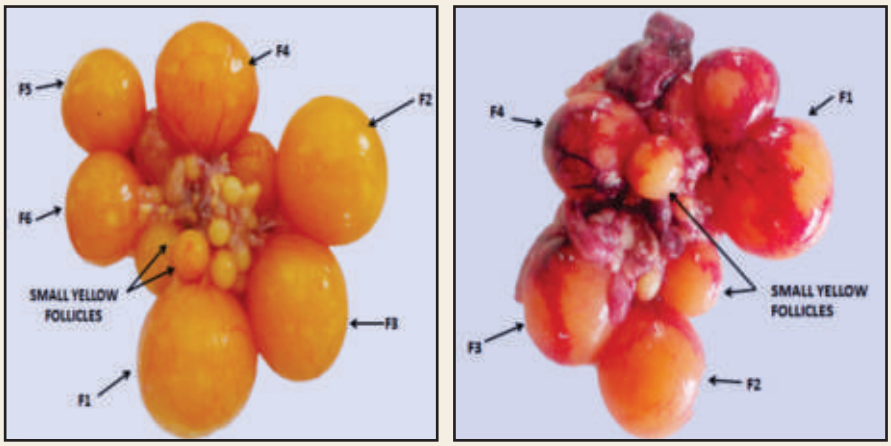


Uncaptured ovum lying in the abdominal cavity of a laying hen

In modern broiler breeding hens the incidence of internal laying has markedly upsurged on account of alterations in sex steroids receptor system at infundibular level probably contributing to weakened ova capturing ability. This finding has opened the ways to improve the number of eggs around the age of sexual maturity and thereby obtaining additional day old broiler chicks.

3. Addressing Reproductive Dysfunction in Broiler Breeder

A major health problem for broiler industry is reproductive tract irregularity where in breeder hens are more prone to Erratic Oviposition and Defective Egg Syndrome (EODES) i.e., follicular atresia, internal ovulation, production of soft shelled eggs, multiple yolk eggs and ovipositions not occurring in sequences. To address these issues the present concept was developed wherein the broiler breeder hens were injected with GnRH analogue (Buserlin acetate) at 200µg/Kg BW from 20-30 wks of age at weekly interval with timing of 30 min prior to expected time of ovulation. Hen housed egg production improved to 22.3% with lower incidence of double yolk eggs (3.59%). Ovarian follicular weights increased to 72.36 g with simultaneous increased of liver weight from 41.4 to 57.13 g. Serum level of corticosterone and leutinizing hormones were reduced (24.40 µg/L) and increased (0.76 IU/L) respectively. Administration of GnRH analogue (at 200µg/Kg BW) also achieved higher fertility of 81.81%.



Ovarian follicular health in breeder hens injected with GnRH analogue (Buserelin acetate)

4. Breaking the Seasonality of Reproduction in Pearl Variety of Guinea Fowl

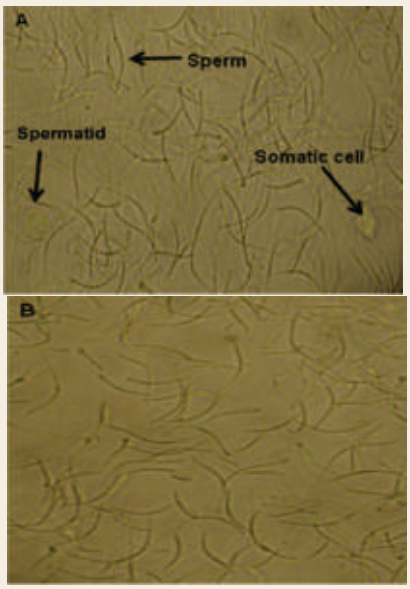
Guinea fowls are seasonal birds with average egg production of 90-110 eggs from March to September i.e. during the period of longer day length and intense sunlight. Seasonality of reproduction/ egg production is therefore, a major problem limiting its egg production and hindering large-scale commercial production of Guinea fowl. Combination of dietary and photoperiodic strategies were used to break the seasonality of reproduction during winter (December-March) aimed for reducing the age at first egg thus extending the length of laying period and ultimately improving the egg production. Exposure of guinea fowls to 18 h photoperiod with dietary provision of 20% protein, 120 ppm of Vitamin E and 800 µg of Selenium triggers onset of production with 53-56 % hen day egg production, advancing the age of sexual maturity to 21 wk, with 71% fertility and 76% hatchability.

5. A macro and micro assay for the spectrophotometric determination of serum nitrite and nitrate by copper-cadmium alloy was developed

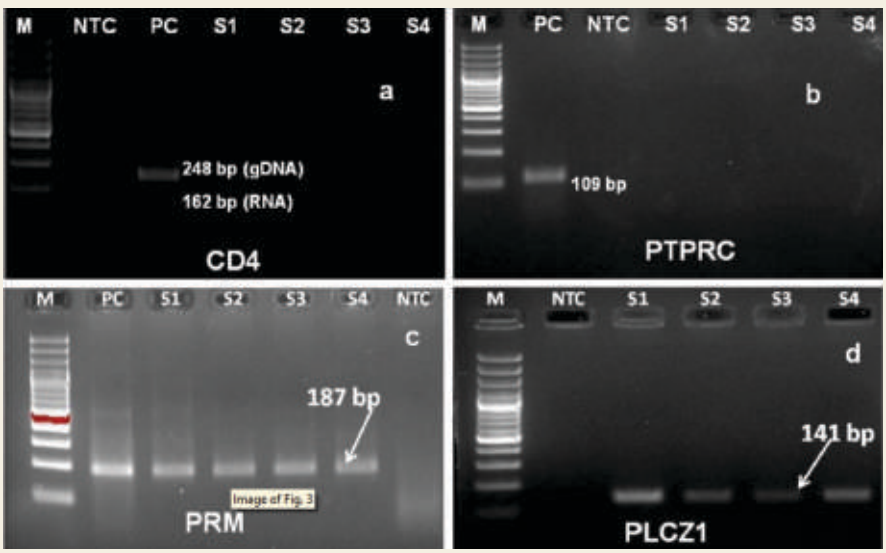
chicken sperm ensures high quality genomic DNA free RNA preparations for micro array and whole transcriptome analysis to conduct functional genomics studies of fertility in poultry. Further, a simple PCR method to amplify high GC rich PRM gene would help in studying its role in fertility and in genome imprinting. The presence of PRM and PLCZ1 transcripts in chicken sperm indicates their functions in fertilization and embryonic development in chicken.

8. Simple Assay for Determination of Nitric Oxide in Biological Samples

Nitric oxide plays a significant role in neurotransmission, critical reproductive events like ovulation and host defense against invading microorganisms. Several other critical functions of this molecule have been unveiled with the recent stream of research in biological systems. A simple macro and micro assay for the spectrophotometric determination of products of nitric oxide (nitrite and nitrate) was developed. Nitrite/nitrate in the biological samples can be estimated in a single step by this method. The principle of the assay is reduction of nitrate by copper cadmium alloy followed by colour development with Griess reagent (sulfanilamide and N-naphthyl ethylene diamine) in acidic medium. This assay is sensitive to 1µM nitrate and is suitable for different biological fluids including sera with a high lipid concentration. The copper-cadmium alloy used in the method is easy to



Sperm purification (A) Before (400×) and (B)After (400×) using standardized protocol



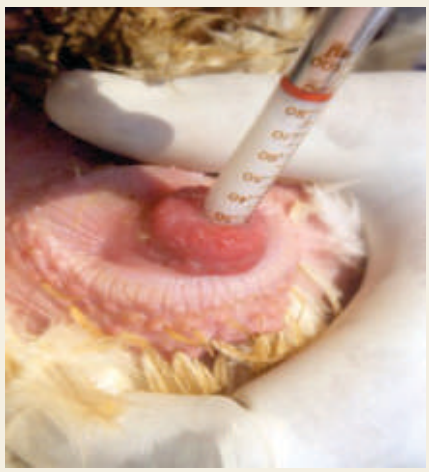
Agarose gel image showing PCR results in sperm RNA samples. (a) Amplification with CD4; (b) Amplification with PTPRC; (c) Amplification with PRM; and (d) Amplification with PLCZ1. M – 100 bp marker; NTC – non template control; PC – testis RNA sample; S1–S4 – four representative sperm RNA samples isolated by RNAzol.

prepare and can completely reduce nitrate to nitrite in an hour. The method provides a simple and cost-effective assay for the estimation of stable oxidation products of nitric oxide in the biological samples.

9. CARI Poultry Semen Diluent for Artificial Insemination

Commonly available chicken semen dilutors are complex in composition which are time consuming and expensive for routine use. Due to these problems, such dilutors are not feasible under the field conditions.

CARI Poultry Semen diluent allows for successful preservation of chicken semen at refrigeration temperature for 24h with higher fertility rates. This diluent works optimally at different dilution rates ranging from 1:2 to 1:6 depending upon the number of spermatozoa in freshly ejaculated semen and duration of storage. At highest dilution (1:6), fresh semen (5.34 × 109 sperm/ml) collected from a single cock can cover up to70 hens (@0.05 ml/hen) in a day and 280 hens in a week under artificial insemination (AI). With this technology, it is possible for extended storage up to 48h of semen derived from diversified poultry species (turkey, duck and guinea fowl) which open up the possibilities for semen transportation across the country. This diluent eliminates the need for high number of males, for instance if a poultry farmer maintaining 100 cocks for natural mating, it can be reduced up to 7-10 cocks by adopting this technology. A farmer can save ₹ 441.00/d (90×4.90= ₹ 441.00) or ₹ 1,60,965/ year by eliminating 90 cocks out of 100 by reducing the feed, housing and labour requirements. Eliminated males can be replaced by the same number of females for economic poultry production.



10. An Easy Technique for Monitoring Intestinal Nutrients Uptake in Poultry

A vast range of feed ingredients and their by-products are being used in the diets of poultry. Besides, several feed supplements are also being incorporated in the diets to ensure optimal feed intake, digestion and/or absorption. An easy and simple in vivo technique under laboratory conditions has been developed to ascertain the uptake of various nutrients (calcium, phosphorus, glucose etc.) through the intestine of chicken.

11. Standardization of Measurement of Arterial Blood Pressure and Heart Rate in Broilers

Blood pressure and heart rate can be measured invasively using blood pressure recording system. For this purpose, anaesthetic combinations of Ketamine and Diazepam were standardized (based on least cardio-depression attained) for broilers and doses @

50 and 3.5 mg/kg body weight, respectively were found to be optimum ~~to produce~~ anaesthesia for 50 min without affecting blood pressure. Primary branch of right brachial artery was exposed carefully under dissection microscope and cannulated with, 20G polyethylene cannula. The other end of the cannula was connected to pressure transducer through three-way stopcock. The entire tubing and transducer were filled with heparinised saline (100 U/ml). The pressure transducer was connected to bridge amplifier and all the measurements were made with Labchart 7 data acquisition system. Before running the programme an initial manual pressure (100 mm of Hg) was given to the assembly to prevent any back flow of blood from artery. This transducer line is opened by turning three way stop cock to connect with the arterial blood and the setup was run for 50 min. After stabilization period, the mean arterial pressure and heart rate were calculated from the recorded values.

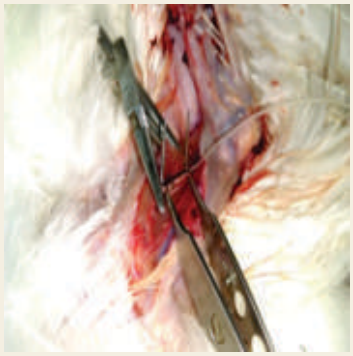
12. Development of Physiological Scores for Assessing Heat Stress Tolerance in Broilers

An attempt was made to develop a physiological index for assessing the extent of heat stress impact on fast growing broilers by considering arterial blood pressure, heterophil to lymphocyte ratio, corticosterone. A coefficient was defined for each criterion, named "Scoring Coefficient" that was multiplied to the result of particular attribute for specific BW group. The sum of multiples makes final score for each BW group. An aggregate

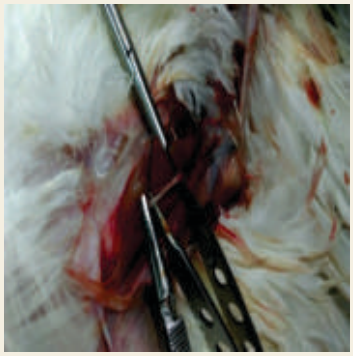
Preparation of site

Dissecting muscles to expose left brachial artery

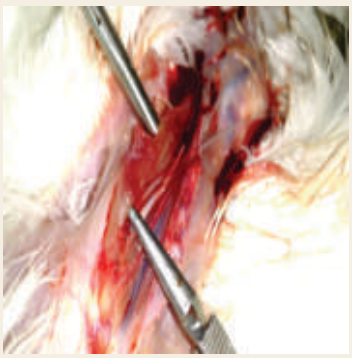
Exposed left brachial artery



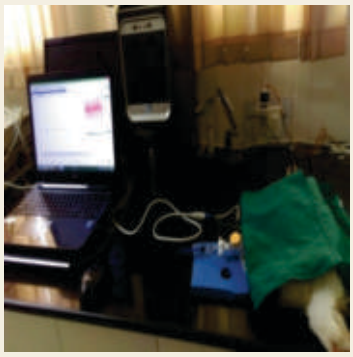
Inserting canula into the artery



Securing canula with thread

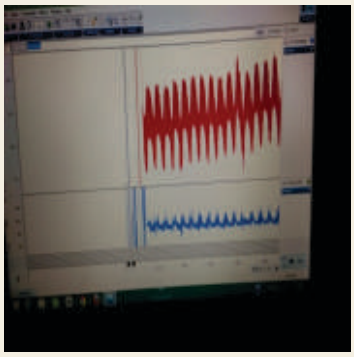


Neatly fixed canula into the artery



Connecting artery to blood pressure system through three way stop transducer

Three way stop cock transducer



Recording of stabilized peaks

Process employed in the recording of arterial blood pressure in broiler chicken

coefficient-1 was distributed among various physiological determinants based on their importance in the occurrence of heat stress. Broilers with higher coefficient scores are considered to be more prone to heat stress poor evading responses.

Managemental strategies to enhance production

1. CARI-DAC Biogas Technology

This technology aims for all weather biogas generation using poultry excreta as an exclusive source with no addition of cow dung. It is an eco-friendly technology that reduces water foot prints as slurry in digester is being re-utilized as dilutor for poultry excreta. This DAC technology generates one cubic meter of biogas from 12-13 to 19-20 kg poultry excreta in summer and winter seasons, respectively. One cubic meter biogas is sufficient for cooking (blue flame) 3-times meals of an average family comprising of 4-5 members. Besides, the generated bio-gas can be utilized as a heat sources during brooding. Spent slurry, byproduct generated from this technology has good manure value and germination potential and can be easily applied in agricultural fields for organic crop production. It will not have burning effect on plants which is a common problem with crude poultry excreta. The excreta of 5000 layers birds has capacity to produce approximately 4100 kg biogas per annum whose market value will be around ₹ 1.31 lakh (@ ₹ 32.00 per kg). There is potential to produce around 128 tonnes of manure from spent slurry of bio-gas. The value of this manure will stand around ₹ 2.56 lakhs on urea, phosphate, potash and micronutrient equivalence basis. Therefore, this technology has great potential of value addition to the tune of 5-6 times from invaluable poultry excreta. Besides, generating the financial gains to the poultry farmer, this technology has enormous positive impact on environment by drastically reducing pollutants, bad odour and flies thereby also helping in accomplishing the Sawach Bharata Mission.

Bio-gas-collector

Anaerobic digester

Bio-gas cylinder

Bio-gas compressor

Bio-gas plant set up with utilization as a cooking gas (blue flame)

2. Low Cost Poultry Incubator from Recycled Waste

This technology offers an effective alternative to the costly incubators utilizing the scrap produced in the form of discarded consumer durables such as refrigerators with required modifications. A low budget incubator has been fabricated utilizing the waste material capable of hatching 400-500 chicken eggs. The required components can be easily sourced to fabricate these low cost incubators suitable for rural poultry farming on DIY (Do It Yourself) basis. The main feature of this technology is that it does not require complex technical knowhow and costs meagre amount of`5000-6000. This technology allows egg setting and hatching activities simultaneously in single cabinet with overall hatchability of 85%. There is a provision for running on DC/AC supply with minimum power of 300 watts. Invertor /battery/solar panel power source is sufficient to run the equipment during power shortages/failures.

3. Cage Space Requirements for Commercial Layers is Redefined

Floor space of 540 cm^2/bird is sufficient for commercial layer for achieving optimal production, egg weight, albumen quality and yolk colour; ensuring better welfare with higher immune-competence and lower incidence of stress indices and pecking incidence and better behavioural observations. Further increasing the floor space beyond 540 sq cm is not providing additional benefit / welfare to the birds.

4. Standardization of Transportation Time for Broiler Chicken

Transportation of broilers chicken in India is stressful and may lead deterioration of meat quality. Increase in the duration of transport for more than 4h significantly compromised the welfare parameters like Gait score, Run away test and Tonic immobility ($P<0.05$). In addition to this it also affected H/L ratio ($P<0.05$) which indicates increase in duration of transportation increased stress in broilers. Transportation time of more than 4h have deteriorating effect on meat quality as well as overall welfare of the birds. In order to evaluate the effect of lairage time, an experiment was conducted with 1, 2 and 4 h of resting period. A pre-slaughter rest time of 30 min can be provided for recovery of the birds after transportation. So, it can be concluded that more than four hour transport negatively affects meat quality as well as welfare in order to reduce this stress, 30 min resting period is required.

Runaway test in control group

Tonic immobility test in

5. CARI Farming Model of Backyard Poultry with Moringa Plantation for Doubling Farmer's Income

A "Giri Gram Takniki Park" inspired from concept of integration was developed for Backyard Poultry Production with Moringa, Vermiculture, Maggots, Seasonal fodder and other technologies in one acre land (64m x 64m) with capacity of 3600-4000 birds. Model specifications are

- Indigenous chicken breeds and their corresponding crosses viz. Kadaknath, CARI Shyama, CARI Saloni, Aseel Peela and CARI Nirbheek.
- Houses for night shelter with dimensions of 20'×15' using low cost materials like bamboo, thatch, polythene sheet, fiber sheet on iron pipe frame.
- Plantation of 500 Moringa saplings in about 2000 m^2 area.
- Rotational cropping with the cultivation of Berseem (legume rich in protein) and Cowpea/other suitable crop in winter and summer seasons respectively.
- Five vermi-beds (3'×10'), four maggot incubators (250L each) and 2'×30' floor maggot bed for generating a source novel protein for birds.
- Feeding inputs: Birds are being fed with about 50g seasonal green fodder and moringa + earthworm (10g) +maggots (10g) +50g compound feed along with 7-8 h free range foraging in one acre land.

Poultry products (green eggs and meat) generated by this model can be sold in suitable packing with tagline like, "Organic Poultry egg fed on Moringa". Framers with minimum inputs can easily get more returns, which ultimately help to strengthen them economically and socially with cost benefit ratio of 2.2:1.

Giri Gram Takniki Park, CARI, Izatnagar


Kadaknath birds


CARI Nirbheek birds


Maggot Incubators (250 lit)


Vermi-compost

6. CARI Model of Backyard Poultry Rearing

Backyard poultry rearing is proved to be a successful means of sustainable livelihood for rural landless and marginal farmers; especially the women farmers. "CARI model of backyard rearing" is a comprehensive scientific package which has been successfully tested by thousands of village farmers of tribal districts of Odisha. The model envisaged:

Complete eradication of Ranikhet disease from the area under operation through mass vaccination (R2B);Sensitization of farmers about economic importance of backyard poultry rearing; Training through audio-visuals about scientific process of backyard poultry rearing; Construction of low-cost indigenous poultry house with locally available material; Input (Day old dual variety colour chicks: "CARI Debendra", chick mash for brooding period, feeder and waterer); Capacity building through practicing vaccination like Lassota and other medication and management; Monitoring of activity/bird's performance; Booster dose vaccination of R2B; Extending natural feed resource for proper growth; Segregation and disposal of male birds in the flock at pre-laying stage; Arrangement of laying nest; Provision of extra calcium to hens for better egg production; Re-introduction of another lot of day old chicks; Gradual disposal of old un-productive hens; Marketing of birds and eggs at

reasonable price; Continuation of the process; and Horizontal expansion of the programme. It was found that farmers adopted the model successfully and could able to earn around Rs. 14,000/- per annum that aids to their livelihood in a better manner.

7. Low Cost Housing Models

Five different types of low cost poultry houses have been designed for housing 120 broilers or 60 layers. These houses are eco-friendly and within the reach of the poor farmers. The houses as designed are made up of bamboo and tarpoline sheet roof, terracotta tiles mud, brick and asbestos sheet roof, bamboo and plastic sheet roof, and wire net and hay roof which are approximately costing ₹ 19,000/-, 12,500/-, 25,000/-, 18,000/- and 15,500/-, respectively.

Bamboo and tarpoline sheet roof house

Terracotta tiles mud house

Wire net and hay roof house

Brick and asbestos sheet roof house

Bamboo and plastic sheet roof house

8. High altitude Poultry farming

Because of climate change and increasing demand and human population the production pressure on poultry in plain area is more. Also the cost involved in environmentally control house is more therefore possibilities in hill agriculture were exploited. Hill poultry research especially in physiological adaptation is need of hour so we have conducted research in Mukteshwar (Uttarakhand). This is helpful for improving nutrition and economy of hill population and will reduces the production cost due to

local production. Under this plan different training Programmes were also conducted for capacity building. The management practice like floor space requirement, Cage Vs. Floor etc. of dual purpose bird like CARI Debendra, CARI Priya, CARI Sonali Desi birds, turkey were studied and standardize. This research is immensely helpful for changing hill economics and pushing tourism further.

9. California Colony Cage for Commercial Layers

To provide better welfare and improvement in production potential California colony laying cages have been designed and fabricated having width 115 cm, depth 47 cm and height 43 cm to house 5-6 laying birds.

10. Design and Prototype of Quail Farm Appliances

In order to popularize quail farming, battery brooders, individual and colony laying cages, feeders, waterers, setters and pedigree hatching boxes etc. were designed and fabricated.

11. Polythene pond rearing system

ICAR-CARI, Regional Center, Bhubaneswar has developed a breakthrough technique in duck rearing under Indian conditions. Polythene Pond rearing system eliminates the need for natural pond or river and ducks can be well managed anywhere by creating this artificial pond.

Pond preparation: A uniform pit with 1.5-2.5 ft depth can be dug on the ground to a dimension of 6ft x 4 ft and 5ft x 5 ft to achieve rectangular and square layouts respectively. This can facilitate at least ten adult ducks. Around 300 lit of water are required to fill the pit and half of water needs to be changed for every 10-12 days. The inner sides of the pond are completely lined with thick polythene sheets of 7-8 ft width. The outer edge of the sheet should be properly secured using large stones to avoid slipping of sheet inside, while filling with water. It can also be integrated with the surrounding ground in the soil.

HRD Activities

SHORT TERM TRAININGS

The institute organizes two types of training programs on various aspects of poultry farming for different categories of persons. The details of training programs are given below.

A) REGULAR TRAINING PROGRAMMES

1. Farmers' training:

It is an orientation training to start poultry farming. Three batches of short-term training on poultry production management (6 days duration) are being organized at the Institute every year. Any literate person is eligible for enrolling to the course. Enrolment fee is Rs. 700/- for General/OBC candidates and Rs. 400/- for SC/ST candidates only. Application forms can be obtained by writing to the Head, Technology Transfer Section, CARI, Izatnagar, Bareilly-243122 (U.P.) or can be downloaded from the website. (https://icar.org.in/cari/Application_Form.pdf)

2. **In-service personnel training**

Specialized training courses on poultry farming are organized at the Institute for in-service personnel of various State Government Departments to update them with the latest technological know.

3. **Sponsored training courses**

Sponsored training courses on poultry production management are being organized time to time on demand for the farmers nominated by Govt. Dept and NGOs.

Contact Person: Head, Technology Transfer, CARI, Izatnagar-243122 (UP) INDIA

Phone: 0581-2300204, E-mail: mpsagar59@rediffmail.com / cari_director@rediffmail.com; FAX: 0581-2301321

B) SPECIALIZED TRAINING COURSES

Institute offers following "Specialized Training Courses" for Veterinary Officer/ Technical Personnel of various Departments/ Institutions including Public/Private Organizations and persons dealing with poultry production/ processing/entrepreneurial development & project formulation, etc.

Specialized Course Calendar (Every year)

Sl.No.	Name of the Course	Period (approximate dates)
1.	Poultry Hatchery Operation	April 13-25
2.	Broiler Production	May 11-23
3.	Guinea Fowl Production	June 15-27
4.	Layer Production	July 13-25
5.	Poultry Diseases & Biosecurity Measures	August 17-29
6.	Poultry Entrepreneurial Development & Project Formulation	September 14-26
7.	Poultry Feeding & Quality Control	October 5-17
8.	Artificial Insemination in Poultry	November 16-27
9.	Poultry Processing & Products Technology	December 7-19
10.	Backyard Poultry Farming	January 11-23
11.	Turkey Production	February 15-27

Duration: Each specialized training is of 12 working days duration.

Course Fee: The fee for each course is Rs. 5000/person.

Eligibility: For all courses, the candidate must be a graduate in any stream.

How to Apply: Brief resume supported by educational records and forwarding/ sponsoring note from the employer may be sent to the Director, CARI, Izatnagar, Bareilly-243 122 (UP) or e-mail to director.cari@icar.gov.in / cari_director@rediffmail.com / drbiswas007@gmail.com.

Boarding & Lodging: The candidate may avail the boarding and lodging facilities at CARI Trainees Hostel-cum- Guest House on the payment basis (@ about Rs. 450/person/day) as per ICAR norms.

Fee Payment: Selected candidates should deposit the Course Fee (Rs 5000/ person/ course) through Cash/DD drawn in favour of Director, CARI, payable at SBI, CARI Branch (Code No.7027), Bareilly.

Certificate: The trainees will be awarded with a Training Certificate from the Director, CARI, Izatnagar after successful completion of the training.

Contact Person: Head, PGE&T, CARI, Izatnagar-243122 (UP) INDIA

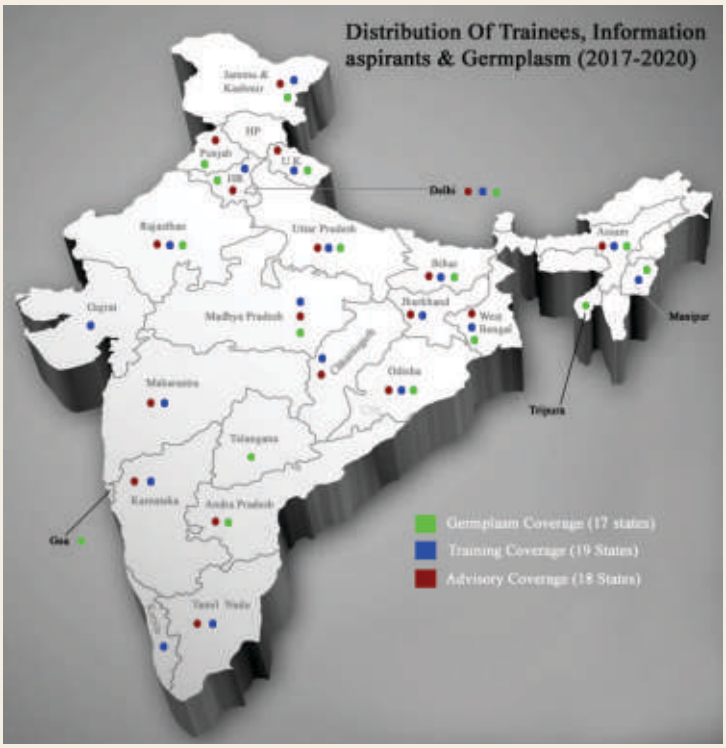
Phone: 0581-2300204, 09837836313 (M); E-mail: drbiswas007@gmail.com / cari_director@rediffmail.com; FAX: 0581-2301321

B) Total trainees trained and germplasm supplied (last 3 years)

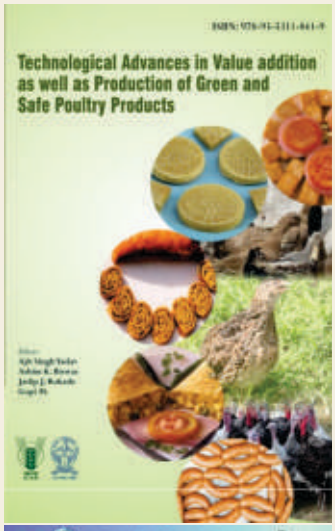
Year	Regular Training	Specialized Training	Sponsored Training	Total
2017-18	275	50	10	335
2018-19	233	92	15	340
2019-20	197	123	41	361

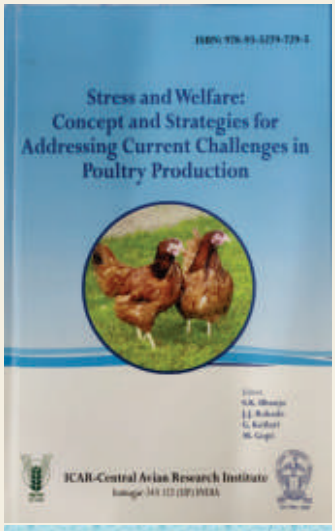
Period	Germplasm supply						Total
	Broiler	Layer	Desi Fowl	Turkey	Quail	G.Fowl	
2017-18	1,47,644	31,254	42,936	5724	1023	1721	2,30,302
2018-19	1,04,739	35,326	52,006	5645	12,291	-	2,10,007
2019-20	53,267	12,300	22,591	1532	7,352	3,027	1,00,069
Total	3,05,650	78,880	11,7533	12,901	2,0666	4,748	5,40,378

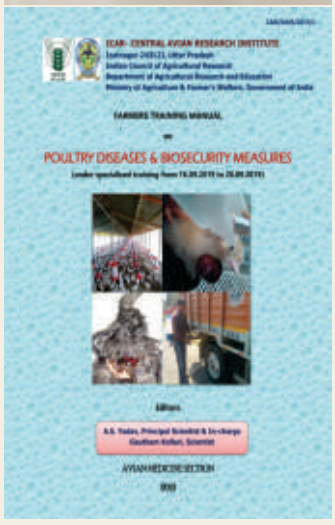
CARI
at a glance

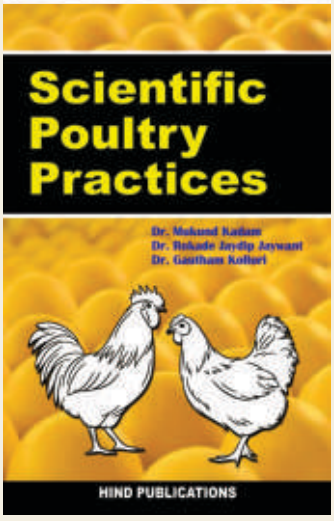


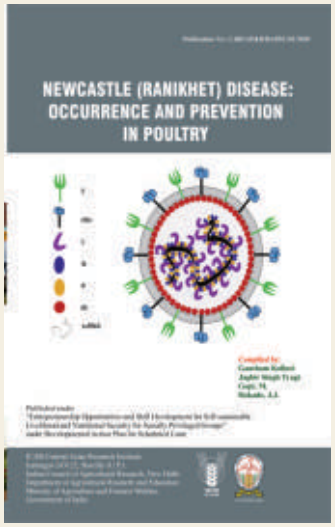
CARI Publications











Success Stories


Success Stories

CHOUDHARY & CHAUHAN FOODS

Dr. Pramod Choudhary

Egg Formula

Cut Egg Foods

Chicken Meat Bites

Dr. Pramod Choudhary

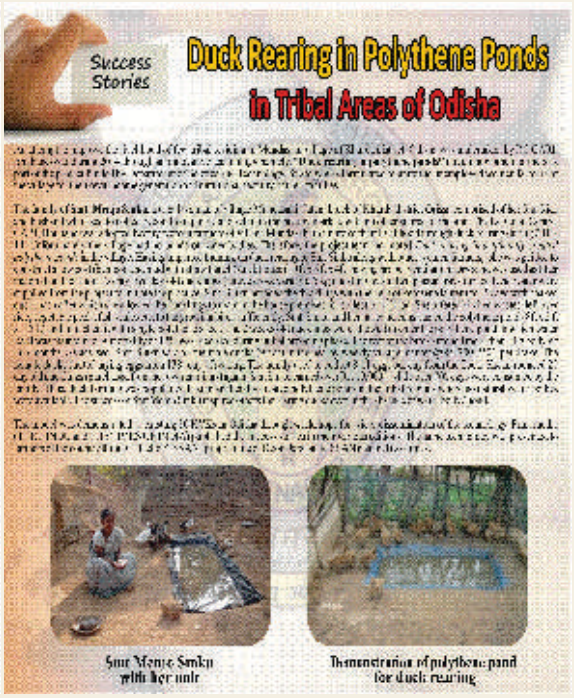

Success Stories

Duck Rearing for Sustainable Livelihood in Keonjhar district of Odisha


Success Stories

Success Story of CARI Model of Backyard Poultry with CARI-Debendra Chicken

CARI Debendra (CD) the most suitable chicken variety under free range management was introduced to 1007 numbers of rural farmers (marginal and landless) of Keonjhar, Sambalpur and Mayurbhanj districts of Orissa as a part of activity under the Model of Agricultural Innovation Project (MAP) implemented at Regional Centre, CARI, Bhubaneswar, Odisha. CARI model of Backyard poultry rearing was adopted by the beneficiaries in the study area. Vaccination (RD) of indigenous stock, training to farmers brooding of chicks up to 8 days, vaccination and medication of birds as per recommended schedule, monitoring and performance recording, economics and impact assessment were undertaken while implementing the project. Almost all project farmers surprised by assured the results and economical income of the unit of over Rs 16,000/- in one year. Other farmers of the nearby villages encouraged by the success of project beneficiaries, also started rearing birds in the same pattern resulting in horizontal expansion of the technology.


Success Stories

Duck Rearing in Polythene Ponds in Tribal Areas of Odisha

Smt Monica Sinku with her unit

Demonstration of polythene pond for duck rearing

Success Stories

M/s Cocks Coo Organic Farm

Faridpur, Bareilly

Mr. M.P.S. Yadav, initiated his startup venture M/s Cocks Coo Organic Farm in Dec. 2017 in the village Sahajanpur, Ilaka Mehtarpur Karor, Block and Tehsil Faridpur, Bareilly, U.P. under contractual arrangements with M/s Shugana Foods Pvt. Ltd. having its branch office in Bareilly, U.P. He got his firm registered vide registration No. B 14894 (under societies registration act, 1860), and also designed an attractive logo for his products. He got his son trained at CARI, Izatnagar in poultry farming in 2017.

His total investment was Rs. 17.25 lakh towards establishing his **Commercial Broiler Farm,** with a capacity to produce 6000 broilers in deep litter in all-in-all-out rearing system. He took a bank loan of Rs. 12.50 lakh for establishing his broiler farm. During winters, the contracting firm allows 1 sq ft per bird whereas during summers, the space allowance is increased to 1.5 sq ft per bird. Thus, during summers, he is able to produce 4500 birds per batch as against 600 birds per batch in winters. He has also employed two persons on his farm on a monthly salary of Rs. 7,000/- each. Mr Yadav, having motivated with the success of his broiler farm decided to expand the capacity of his farm and his second shed of similar capacity has almost been constructed. He is able to gross about Rs. 16-18/- per bird. After meeting expenses on labour, litter and electricity, he is able to save around Rs. 10/per bird. Now he is a well-established poultry farmer in this region.

Success Stories

Commercial Broiler Farm

M/s Ambey Suri Poultry Farm

Yakub Ganj, (Baheri) Bareilly

A 23-year-old B. Tech. graduate, Shri. Surendra Pal, a native of village Shiv Nagariya, post Yakub Ganj, (Baheri) Bareilly started his business with by commercializing backyard poultry. In order to get loan from the bank for establishing his **Commercial Broiler Farm**, he approached the ABI Centre, ICAR-Central Avian Research Institute, Izatnagar. The Centre assisted him and provided the required detailed project report (DPR) amounting Rs. 12,00,000/- (Rupees twelve lakh only) including his own share of 25%. He then established his firm by the name **M/s Ambey Suri Poultry Farm** (registration of the firm is under process) with 1760 broiler birds at the initial stage. After some time, he faced some management problems viz. mortality, diseases, etc. in his farm, however, with consistent support and guidance from the scientists of the Institute, he overcame those problems.

After a period of one year of operation, **M/s Ambey Suri Poultry Farm** has shown considerable growth and presence in the local markets and is planning to expand his business to nearby big cities. He also wants to enhance the ambit of his poultry business by including processed products and other poultry species along with chicken. He has been into production of broiler birds for a year and has employed 2 persons in his farm offering an average salary of Rs. 7,500/- per month per person. He has always been not only encouraging local farmers for poultry farming but also helping them in establishing their poultry units. His annual turnover has grown to Rs. 15,00,000/-. For better support and guidance, he is constantly in touch with CARI scientists who have been providing him all kind of technical help, whenever needed.

Success Stories

Backyard Poultry Farming

M/s Bhumi Enterprises

Village&Post Balipur, Ahmedpur, Bareilly

Mr. Yogender Pal Singh, Proprietor, M/s Bhumi Enterprises, Village & Post Balipur, Ahmedpur, Bareilly, age 45 years, has been into backyard poultry farming for the over last 10 years. Of late, in Feb. 2017, he decided to bring his experience and knowledge to a broader level by commercializing backyard poultry. He approached the ABI Centre at ICAR-Central Avian Research Institute, Izatnagar for assistance in establishing his commercial poultry unit. He was assisted in the matter and a detailed project report (DPR) was prepared for Rs. 20,000 to suit his requirements so that he could avail the required loan facility from the bank.

He then, registered his firm by the name of **M/s Bhumi Enterprises**, Bareilly **(registration No: 09HAFPS7842AIZF)** and designed an attractive logo. He started initially with 5500 birds and slowly increased his farm capacity to produce 1,45,000 birds per year in deep litter system by taking 6-7 batches per year.

For the last one year, he has been into production of broiler chicken and has employed 4 persons in the farm offering an average salary of Rs. 7500/- per month per person. His annual turnover is over Rs. 25 lakh. His success over the years has marked his presence in the local markets and also in the nearby cities. He is now planning to expand his business to New Delhi and other suburbs. He is constantly in contact with CARI scientists for technical support and guidance from time to time.

CARI
at a glance